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WHIRLWINDS

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OF INDIA.

WHIRLWINDS AND DUST-STORMS OF INDIA.

An Investigation into the Law of Wind, and Revolving Storms at Sea; with numerous illustrations drawn from nature, bound separately; and an Addendum on Sanitary Measures required for European Soldiers in India.

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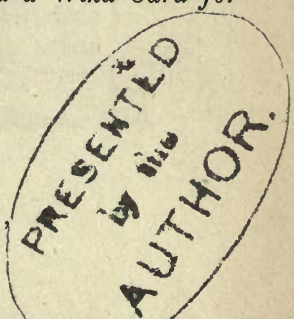

"Facts have special value: They are the data of all just reasoning, and the primary elements of all real knowledge."
Sir Richard Phillips.

"They that go down to the sea in ships, that do business in great waters; these see the works of the Lord, and his wonders in the deep.
For he commandeth, and raiseth the stormy wind, which lifteth up the waves thereof."
Ps. 107. 23-25.

LONDON. 1860.
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"Induction is a process of thought by which we rise from particular facts to general truths relating to whole classes of objects or events, and from these again to still higher and more comprehensive generalisations, when two or more classes are compared and found to resemble each other in certain respects — a process in which we are guided in every instance by the perception of *analogy* between the cases compared, and in which we must confine our conclusion strictly within the limits to which the analogy is known to extend. The conclusion may go far beyond the *particular facts* which have been actually observed, but it cannot go beyond their *known relations* and *ascertained analogies;* if it transcend those, it is no longer an inductive inference, but a fanciful and groundless imagination."

The North British Review. Aug. Numb. 1859.

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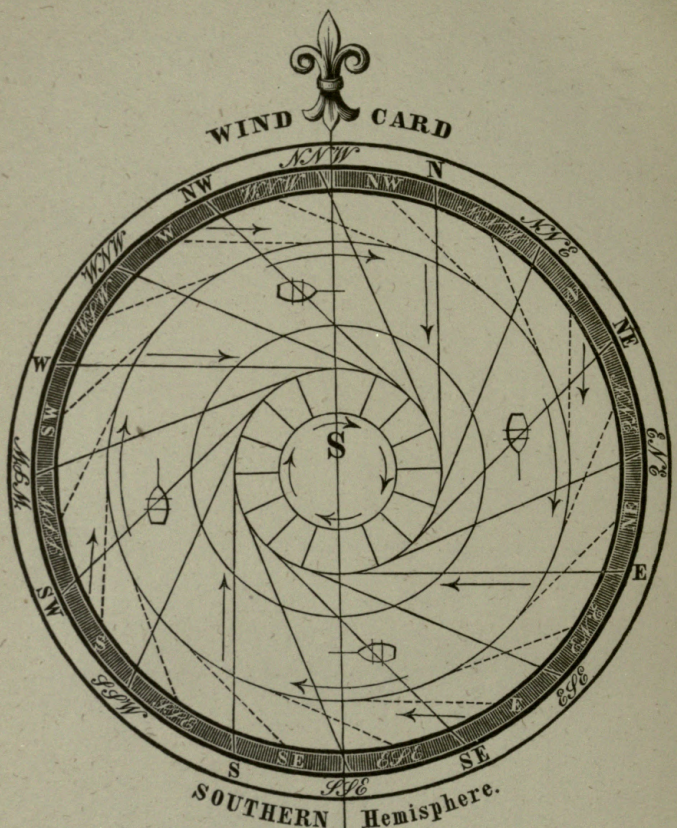
The above representation or Storm Cards, Pl. I. X. is drawn on the principle explained at



The above representation of Storm Cards, Pl. 19, is drawn on the principle explained at

page 21; the Cards are similar in size to the Horn Cards invented by Colonel Sir Wm. Reid.

page 21: the Greek navigator so nice to the Horn Cape he invented by Colonel Sir Wm. Leak

PART I.

PARIS.

CUR SPIRENT VENTI?

The present investigation is directed to the solution of a question which has attracted the notice of philosophers in all ages, "*Why the winds blow?*" Notwithstanding the attention and labour bestowed upon the subject, it must be acknowledged, that this particular branch of science is still in its infancy; and that much remains to be discovered, before we can arrive at any certain conclusion respecting the laws which regulate this complicated phœnomenon.

The following remarks contain the result of a series of observations conducted between 1847 and 1853 in N. W. India, with the intention of elucidating the law of storms.

A selection has been made of the important and interesting details collected from actual observation during that period; and prominent parts seized upon to serve as data in reasoning. Numerous plates have also been introduced for the purpose of elucidating the Author's views, — and of affording an opportunity to lovers of science for studying the phœnomena which he has observed.

Most persons residing in India, must have noticed with feelings of curiosity lofty pillars of dust traversing the surface during the day time, and thought to themselves, — What are they? From whence do they come? Whither do they go? By what laws are they influenced? Attempts have been made to answer these questions by saying generally, that the pillars thus seen are mere eddies of dust, caused by conflicting currents of air — effects of rarifaction — obstructions from terrestrial bodies; &c. &c. But such meagre explanations, so far from solving the difficulty, do but add to it, and must fail to satisfy any one who seeks to dive into the mysteries of nature, and refuses to take for granted what cannot be proved by a careful reference to cause and effect.

Ever since 1847, when I ascertained by experiment the electric origin of Dust Storms and Whirlwinds, my attention has been constantly directed to the phœnomenon of wind; and I have been careful to note every circumstance likely to throw additional light on a subject imperfectly understood. In 1850 and 1851, when encamped with the Lahore Artillery Division on the extensive plain of Meanmeer, near Lahore, an opportunity was afforded for prosecuting the enquiry with some hope of success. Accordingly I erected before the door of my tent, a wind Vane and an Electrical Conductor, and watched the passage of the dust whirlwinds as they swept by; and when the sun's rays were not too overpowering, I followed them on foot, or on horseback, or in a buggy, at the risk of being accounted mad; (for who could see a man chasing the dust, and looking up towards the sky when nothing appeared to be there, without some such conclusion,) note-book and pencil in hand, noting and sketching as I went along, — by which means I shortly accumulated facts, which have enabled me to add to the store of knowledge already acquired and perhaps, to form a true theory respecting winds.

The most prominent facts then obtained, were published in the Bengal Asiatic Journal for 1850 — 51 and at Lahore, in an Essay to which the local governments of Calcutta, Agra, the Punjab and Bombay most liberally subscribed. But as the facts then brought out, are not generally known in Europe, I am induced after a lapse of nearly ten years to offer them again to notice in a more comprehensive form, feeling assured that the advances which science has made since then, will not militate against the admission of truths, however opposed they may be to long cherished theories.

Storms, Whirlwinds, and **Waterspouts,** and all kindred phœnomena, are caused by an electrical Meteor in the form of Cylindrical Columns, working together in a spiral manner, and possessing rotatory and progressive motions, *per se ipsos;* emanating from the higher regions of the atmosphere, and traversing the earth's surface.

The columns are in every instance the exciting cause of the phœnomenon, and of wind in general; the specific character of each, being determined by the particular manner in which the phœnomenon happens to be developed.

They are endued with rotatory and progressive motions, which have the effect of setting in motion the air through which they pass, causing thereby, currents of wind to blow towards the whirling body, all round, and also in the track.

This theory is opposed to that which ascribes everything to rarefaction, — a theory at variance with facts; and which most scientific men of the present day admit is inadequate to explain many of the most striking phœnomena attending storms and whirlwinds. In the words of Sir Richard Phillips, "It is impossible to reconcile the force of winds in storms, and, in truth, to account for storms &c. &c. on the theory which refers everything to mere rarefaction."

The meteor, as now defined, is compounded of a number of electrically charged bodies of a columnar form, possessing, as was before remarked, rotatory and progressive motions.

The simplest state in which these spiral bodies appear, is that of a slender cylindrical pillar about 10 or 12 inches broad, extending to an unknown height in the atmosphere, and capable of being lifted up from, or brought down to, the earth's surface, as the case may be. Plate 1.

This body may be considered the ultimate spiral of the meteor. It is uncertain what these bodies are; for though they exhibit electrical effects, as will be afterwards seen, they are clearly not mere discharges of electricity: as Professor Faraday observed in 1850, when replying to a communication made to him from Lahore, April 18th 1850, on the electric origin of Dust Storms. —

"I received your letter respecting **Dust Storms** not long since and read it with a great deal of interest. The quantity of Electricity which you obtain at the time is enormous, as is manifest by your obtaining electric depositions from metallic solutions; but then the intensity does not seem to have been very high, for you must have been immersed in the Electrifical atmosphere. I have never yet been able to obtain clear ideas of the manner in which such electricity is supposed to be the cause of whirlwinds, waterspouts, and tornadoes. In such waterspouts as I have seen in the Mediterranean, they did not seem at all due to such a cause. That it accompanies them, there is no doubt of, but then, that may be as much in the way of *effect* as cause."

Not mere discharges of electricity — on the contrary, certain facts connected with their development, might lead to the belief, that *they are a permanent indestructible form of imponderable matter, hitherto undescribed, occupying the higher regions of the sky, and liable from certain causes to be diverted downwards to the earth,* where we recognise their existence by the various meteorological phœnomena they give rise to.

Sir John Herschel's account of the formation of the solar spots seems applicable to the present case, and serves to explain what may take place with regard to the matter of which the whirlwind is composed.

"The (solar) spots, in this view of the subject, would come to be assimilated to those regions of the earth's surface, in which for the moment hurricanes and tornadoes prevail. — The upper stratum being temporarily carried downwards, displacing by its impetus the two strata of luminous matter beneath (which may be conceived as forming an habitually tranquil limit between the opposite upper and under currents) the upper, of course, to a greater extent than the lower, and these wholly or partially denuding the opaque surface of the sun below.

Such progress cannot be unaccompanied with vorticular motions which, left to themselves, die away by degrees and dissipate; with this peculiarity, that these lower portions come to rest more speedily than the upper, by reason of the greater resistance below, as well as the remoteness from the point of action which is in a higher region; or that their centre (as seen in our waterspouts, which are nothing but small tornadoes)

appear to retreat upwards" — and again: "It seems worth inquiry whether hurricanes in tropical climates may not arise from portions of the upper currents prematurely diverted downwards before their relative velocity has been sufficiently reduced by friction on, and gradual mixing with, the lower strata; and so dashing upon the earth with that tremendous velocity which gives them their destructive character, and of which hardly any rational account has yet been given." *Sir John Herschel's*, Outlines of Astronomy.

The dynamical effect exerted in the waterspout, whirlwind and the storm, is due to a multiplication of the columnar bodies acting in concert, in a concentrated form, more or less; just as muscular power is the effect of the joint action of the fibres and fibrillae of the muscle. Plate 2.

These spiral bodies, being invisible under ordinary circumstances, pass unnoticed, and are only distinguishable when they become charged with dust in passing over a sandy soil; or with watery particles, when moving over water. Plate 1. 2. 3. 4. 5. 6. 7.

Before proceeding further, it will be necessary to a clear understanding of the subject, to give a detailed account of the phœnomena attending whirlwinds as exhibited in the tropics, and the facts on which the present theory is based.

Dust whirlwinds are common in all parts of India (and it may be inferred that they exist in all tropical climates) especially during the dry season, and present a variety of appearances.

Sometimes, a slender lofty cylindrical pillar of dust is seen, revolving on its axis, — or several such pillars moving on together in the same direction, — or revolving in a circle, — or as a dense cloud of dust, sweeping over the country like a tornado — the cloud of dust occasionally presenting to the view a distinctly columnar structure. Plate 8. 9. 10.

In Northern India, about Lahore, where these observations were made, the smaller whirlwinds always appear in dry windy weather, and are most numerous about February, March and April and throughout the hot dry months; — dissappearing for the most part during the rains, when the earth and sky are moist; again appearing in the Autumn and during the cold season, though much less frequently then.

They occur with singular regularity at certain periods of the day,

commencing about three or four hours after sun rise, and continuing till three or four in the afternoon, when they gradually disappear, being most numerous about midday.

They are rarely noticed after sunset, or at night — though dust storms frequently blow near sun-set, and sometimes during the night. From this periodical variation, it may be concluded that the solar influence is at least a subordinate cause of their development.

They are Electrical. — The fact was proved in 1847 at Lahore, and has since then been verified by hundreds of observations continued during the six succeeding years. *)

The question, *how do the winds blow?* may be answered by attending to what occurs in the case of a small whirlwind, 3 or 4 feet in diameter, moving briskly over a dusty plain, 10 or 15 miles an hour.

We take our stand, and observe in the distance several lofty pillars of dust moving towards us with a somewhat tortuous course, and we plant ourselves so as to meet one of them. The air about us is perfectly still up to the time of the whirlwind's approach; but the instant it strikes us, we are encompassed with conflicting winds and a cloud of dust. The whirl has passed; and we next notice a train of dust broken into minute tortuous eddies following in its wake for several yards; and experience for a short time, during which the whirlwind may have progressed 100 or 200 yards, light fluttering winds, or a calm; — and then, all at once, a strong breeze blows steadily in the direction of the whirlwind for some minutes, with, now and then, a diminution or an increase in the strength of the blast. Afterwards the wind veers and becomes unsteady, and finally subsides into a calm. The same process is repeated over and over again, as long as the whirlwinds last.

The strength and duration of the after breeze always depends upon the velocity with which the spiral column is impelled through the air. When it moves with great velocity, the after breeze may instantly follow the passage, and continue to blow with violence for some minutes after: when the progress is slow, a gentle breeze blows; or there may be no sensible wind at all following.

We further remark, that the horizontal section of the whirling

*) Vide London Philos: Magazine for August 1850, pag. 155. The Bengal Asiatic Journal for 1850—1851 and the addenda to "the Sailors' Horn Book for the law of Storms" by Mr. H. Piddington 1851.

column in contact with the earth's surface, is surrouded with centripetal streams of dust, which **on one particular side, are prolonged to a considerable extent,** forming in some instances, **a fan-shaped train, which strikes the whirlwind obliquely,** sometimes **almost at right angles to the line of its progression, keeping up with it as it whirls along,** with a *degree of lagging behind,* the further distant it is removed from the whirling body — like the tail of a comet. Plate 11.

A certain amount of rotative energy in the whirlwind, seems requisite for the full development of this remarkable set of currents. Repeated observation establishes the fact, that these lengthened currents of wind are invariably formed on the side corresponding with the working of the rotation, and the line of progression; — or, the side which is moving in its rotation in the same line with the track; which side we shall call the *side of progression.*

In Mr. Piddington's valuable work on the law of storms, page 293, par. 407, an objection to the whole rotatory and progressive theory of storms is started by some intelligent person, thus. — "How it is accounted for, that the side which is moving in its rotation in the same line with the track, has not the wind double or treble the force of that in the opposite side? — Since it must have, at the same time, a double set of forces, i. e. that of the rotation and that of the progression acting upon it." In confirmation of this reasoning, we do really find, that, in the case of the smaller whirlwinds, the wind does blow with much greater force on that particular side; — and that is probably true of whirlwinds on a larger scale, subject, as they are, to the same description of forces.

Another curious phœnomenon is often observed in a slowly moving whirlwind; instead of appearing as a simple column, the dust whirl in contact with the ground, and for a few feet upwards, is found to be composed of several distinct vortices, or spiral bodies, each one rotating on its axis as it revolves round and round the whirling circle. — Each separate vortex having attached to it in its horizontal section, the same kind of fan-shaped train of dust, as was before remarked with regard to the smaller whirlwind columns. Plate 2.

This remarkable sight gives the idea of a fairy dance round a ring; — and the motions are, from all accounts, exactly imitated by the dancing Dervises of Turkey; one of their holy exercices being to whirl round and round like a top; singly, or in company with se-

veral others, performing at the same time a gyration round in a circle, as if their dance originated in the very phœnomenon now described. We may sometimes watch this motion for a length of time, without changing our position more than a few yards.

The smaller whirlwinds possess an independent power of motion; are liable to sudden augmentation or diminution in their rotative energy, and ascensive force; have been observed to change their direction suddenly without apparent cause; and also to expand and divide into separate columns, like the strands of a rope before they are cut off, and unite again; and, what seems most unaccountable, to reverse the rotation instantaneously when whirling most rapidly.

The cause of the ascent of dust or water is owing to the combined action and reaction of the centrifugal and centripetal forces of the whirlwind in a resisting medium, and may be explained in the following words, quoted from my original communication made to the Bengal Asiatic Society in 1851.

The Electrical spiral rotating and working like a screw from above downwards, sets in motion by its centrifugal action a stratum of air immediately surrounding it; — outside this again, another circle of winds are found blowing centripetally; and the two meeting, will, by their mutual action and reaction, continuous throughout, form an ascending spiral current of air working a reversed spiral upwards; — the two motions being well represented by two coils of wire, wound in opposite directions, laid one over the other. Plate 14.

This result of the two combined actions, may exactly illustrate the force of aggregation or *Gravitation* as propounded by Sir Richard Phillips in 1826 who remarks: —

> "If a progressive motion acted alone on a mass, it would form a train of the rarer parts, and *disperse* them. If a rotative motion acted alone, it would direct the parts in tangents and *disperse* them. Their combination directs the parts to the centre, and the two become a force of aggregation, centripetal force, gravity, or weight."

In the case of the whirlwind column, the *progressive* motion acts from above downwards, in the line of the vertical axis of rotation as well as in the track.

The cause of the centripetal currents may be further explained.

The constant transfer of dust and watery particles from below

upwards, proves that an ascensive current does exist in the diminutive whirlwind, requiring a continuous supply from the adjacent air, which accordingly flows all round the whirling body in centripetal streams, and upwards, with energy proportioned to the power exerted by the centrifugal action — the proximate cause of the upward motion.

We thus see, that the spiral columns are the cause of wind, and they may therefore be justly termed, "*the wings of the wind;*" for, as birds fly by their wings, so, *the wind blows by the instrumentality of the electro-magnetic spiral columns.* According to this view, Gravitation must be considered "the name of an effect" —; a result — not a cause: the proximate cause of gravitation having yet to be ascribed to a higher principle — some one of the great physical powers by which the Creator and Preserver of the Universe carries on the operations of nature, of which the spiral column may possibly be the symbol.

The above explanation of the double spiral movement in the smaller whirlwinds, was published in 1851, and it is satisfactory to find, that the late Mr. Redfield of America entertained a similar opinion as regards a double spiral movement "in opposite directions as regards the *interior* and *exterior* portions of the revolving mass", in a paper read before the American Association at Albany, August 1856, quoted in the London Phil: Magazine for March 1857.

My experience, however, does not exactly coincide with Mr. R's view (if I understand him aright,) of the conical nature of the whirlwind; — or, that "the horizontal areas of the higher portions of the whirl exceed greatly those of the lower portions."

I have witnessed hundreds of whirlwinds, but never saw anything resembling "an inverted cone" as Mr. R. describes: on the contrary, the phœnomenon to which he seems to allude, viz. the "essential portion" of the whirlwind, always appeared to me, in the plains of India, as a *lofty cylindrical pillar,* preserving apparently the same diameter throughout its entire height, for thousands of feet.

It may sometimes present a conical appearance, as is noticeable in the waterspout at sea, from the circumstance of the watery vapour, when raised to a certain height, spreading out from some cause connected with gravity or atmospheric currents prevailing in those regions; but, the integrity of the *column* is, I am satisfied, preserved throughout, to whatever height it may extend into the atmosphere.

The supposed analogy of *aqueous vortices*, referred to in the

same paper, does not hold good in this case. If whirlwinds were, as some suppose, caused by the meeting of two conflicting currents of air, such an idea might be entertained; but as that is not the case, the resemblance cannot be said to exist.

Though usually holding a definitive course with the prevailing wind, and never going against it, the columns have been observed to change their direction suddenly, and to undergo an increase and diminution in their rate of progress.

One of these bodies was once seen, during a calm, moving across an open plain at the rate of about three miles an hour, from E. S. E. to the opposite quarter; as it approached, its speed diminished, till at length, when within 60 or 70 yards from my position, it stood still, whirling up, with increased energy, large volumes of dust for more than a minute; when, suddenly, it set off with quickened speed, six or seven miles an hour, at an acute angle, with the former line of its advance, going from W. S. W. to E. N. E. or thereabouts, and passed over the same ground, and a range of barracks which intercepted its course — when it was lost to view. A similar kind of unexpected shift has been observed during the advance of a slowly moving dust storm.

A few remarks on Dust Storms may now be given.

A Dust Storm or Tornado, is occasioned by an accumulation of whirlwind columns moving *en masse,* or in rapid succession over the earth's surface in a direct or wavy line. It varies in breadth, from several yards, to two miles and upwards; and in length may extend over a space of ten, thirty, fifty miles and more.

The storm generally comes on very suddenly without any previous warning, or barometrical indications, proceeding from any point in the compass. All that we may sometimes notice, is a low bank of dark cloud in the horizon, which rapidly augments, and before we are aware, the storm bursts upon us, and involves the whole scene in midnight darkness.

When it passes over the arid plains of India, it whirls high into the atmosphere vast quantities of dust, which are rolled onwards in huge volumes, forming at times quite a sublime spectacle.

The body of dust commonly appears, when at the distance of 8 or 10 miles, as a long, opaque, arched, continuous, cloudy line, rising from the horizon and occupying a space of 6 to 8 points; and sometimes, when at the distance of 4 or 5 hundred yards from the spectator, is

observed to be broken into distinct columns, each one preserving its position in the moving mass, and having a separate whirling on its own axis, as in the case of the single columns. Plate 8. 9.

After the first sudden burst, violent gusts or squalls succeed one another at intervals, becoming weaker towards its close; when the wind gradually veers and subsides, or continues for a time to blow a breeze in the same direction. Further observation however is required about this latter point.

An insulated wire projected into the atmosphere, and brought into the room, evolves no electricity, up to the time of the Dust Storm's approach: but the instant it strikes the spot, vivid streams of electricity, sometimes an inch in length, doubled or trebled, are emitted with a crackling sound at the extremity of the wire presented to a conductor communciating with the earth; the electric fluid continuing to be discharged without intermission during the storm, and with increased intensity at the recurrence of the gusts or squalls, which mark the passage of a fresh batch of spirals.

On the least fall of rain, which not unfrequently terminates a dust storm, the electric discharge instantly ceases — or is much diminished.

Capt. Scoresby's inability to obtain at sea the least electrical excitation from an insulated wire, fixed to the mast head in the Polar Regions, may be accounted for by the humid state of the air, which according to his account, is "generally in a state of dampness approaching to complete saturation," and becomes a conductor to prevent its manifestation, exactly as is observed in a tropical climate during damp weather, or rain occuring during a dust storm.

Peculiar states of the atmosphere have been observed, when notwithstanding the heat and dryness of the air, no electricity is developed during the passage of the whirlwind columns. An instance of this occured at Lahore in the Autumn of 1850, when from the 19th of August (the day on which the first observation was registered on the subject,) till the 12th of October, little or no electrical excitement was apparent from the insulated conductor; and a gold leaf electrometer was with difficulty affected even by artificial means, and then only for an instant; yet during this time, the spiral columns swept by as usual on certain days. This seems to confirm Professor Faraday's observation already referred to, that electricity, though usually an accompaniment,

may not be reckoned a *cause* of the phœnomenon of the waterspout &c. &c.; and it may likewise be said so of wind.

It is worthy of remark, as tending possibly to connect a cause with the effect, that a considerable amount of sickness from intermittent and remittent Fevers and Dysentery prevailed during the period referred to, which sickness commenced about the first week of August, and continued all September and the greater part of the following month.

As some interest is supposed to attach to the Meteorological Journal kept during that season, it is here introduced. See extracts from Meteorological Journal.

But the regular meteorological monthly tables kept at Lahore, Meeanmeer and Peshawar, during 1850, 51, 52, 53 & 54 are not in my possession, but were forwarded in duplicate to the Medical Board at Calcutta.

The air is usually calm and sultry previous to a **Dust Storm.** On its near approach, a vane, before unaffected by any wind, turns slowly, and points towards the advancing cloud; which may possibly be accounted for by the storm pushing before it a wave of air.

As the gusts pass, the vane sways to and fro rapidly, 4 to 6 points, just as it does when the smaller whirlwinds sweep by; which oscillation is caused by conflicting currents of wind, some in the direction of the track, others blowing obliquely, from the centripetal streams. The atmosphere on such occasions is so highly charged with electricity, that a constant succession of sparks is given off from an insulated wire for hours together; and the air is so dry, that it is impossible to obtain the *dew point* by Daniell's hygrometer, even by Chloroform, which reduces the temperature 35° to 38° Farh. below that of the surrounding air. The *dew point* has sometimes been obtained under these circumstances, by first lowering the temperature of the *black bulb* by means of ice, and then using chloroform.

Evaporation also is, at those seasons, greatly accelerated: upwards of an inch having been registered in the 24 hours during dry windy weather in the hot season.

Lightning does not usually accompany dust storms: when it does, it is (as far as I recollect) of a dull reddish hue, flickering and thready, running in a spiral form over a large portion of the sky at the same instant — lingering on the sight a few seconds, (2 or 3) quite unlike the sudden vivid flash from the cloudy nimbi, and generally

speaking, unaccompanied by thunder; — or it may appear as a diffused gleamy flash.

The passage of the whirlwind column is not attended with any peculiar sounds in *the open air,* as far as my recollection serves, and is not noted in my journal: though hollow whistling moaming sounds, elevated sometimes to roaring or screaming, are always heard from within doors on such occasions; — from which it would seem that peculiar sounds do accompany the passage, and may be conveyed to the ear in advance of the whirlwind itself, as the velocity of sound is so much greater than that of the swiftest moving hurricane.

The sound of a blast at any given moment, rushing with the velocity of 80 miles an hour, might be heard 340 yards in advance of the spiral column causing it. Thus Capt. Scoresby relates an instance where a noise in the upper regions of the air announced the immediate approach of the gale.

> "My father," he says, "once removed his ship from a most dangerous bight in the main ice, where she would probably have been lost, had she remained a few moments longer, in consequence of his having heared the rushing of a storm in the air, while at the mast head. Before the ship was out of danger, a heavy gale commenced, but the sails being set, and the ship under command, she was extricated from the perilous situation. From this circumstance, he imagined that sudden storms frequently commence at some height in the atmosphere, and gradually descend to the surface."

The sound is supposed to be caused by the closing of the air after the swift passage of the spiral body; affecting it precisely as when the air is sharply struck with a cane.

A very slight clinking sound has been noticed in the open air during a dust storm, when the velocity of the wind is not very great, and yet sufficient to keep suspended vast quantities of fine sand mixed with minute particles of mica, of which much of the soil of the Punjab, is composed. The sound may be caused by an infinity of gentle concussions produced by friction of the particles of dust in the air.

The electrical discharge from an insulated copper or brass wire, the size of a small kite string, is not attended with any danger, (as far as my experience goes,) however violent the dust storm.

The strength of the discharge seems to depend upon the size of

the wire, and the height, under certain limitation, to which it projects into the air, as will be seen by reference to Capt. Geldhart's experiment.

Two magnetised sewing needles stuck through a straw with reversed poles, and suspended by a silk fibre within a wire helix, the extremities of which were connected with the two terminations of the insulated wire are deflected during the passage of the gusts, in proportion to their violence.

The American Missionaries at Lahore were accustomed to amuse their pupils by giving them electric shocks from a Leyden jar, charged with electricity during the passage of a dust storm.

Though immersed for hours in an atmosphere of electricity, the body experiences no particular sensations, except it be, perhaps, an unconsciously increased nervous energy in spite of the debililating influence of the climate. In some persons, the hair becomes electrical when combed, and elicits sparks, accompanied with a crackling sound, — and a slight shock has been experienced from stroking a horse's neck, when seated on the saddle.

Iodised starch exposed to the open air (and even in the house at times) is almost immediately discoloured when the whirlwinds are passing: other electro-chemical changes have likewise been observed.

It is impossible to say from whence Dust Storms originate. It may however be confidently affirmed, that they are not caused by conflicting currents of air — or, from the effect of mere rarifaction.

Most probably they emanate from the higher regions of the atmosphere, where a stratum of the Eletro-Magnetic beams or spirals may exist; whence under certain circumstances they are diverted downwards to the earth, and there give rise to all the varied phœnomena of *wind*. — The above facts tend to confirm the opinions expressed by Professor Oersted, Mr. Piddington, and Colonel Sir W. Reid, that the water spout and whirlwind is surrounded by an invisible column of air which is also a whirlwind: — and they likewise harmonise with certain results deducible from the experimental researches of Mr. Peltier on the causes that concur to form the whirlwind and water spout: such as, their supposed connection with electrical action — and the existence of outward circular currents of air occasioned by the gyratory movements of the Meteor as referred to in Mr. Piddington's work on the law of storms, p. 278. Though strictly speaking, *circular* currents do not, and cannot exist,

either in water or air, the eddy in every case being formed by currents, moving in what might be termed curved or involute tangents to a central axis; — the same being true in revolving storms; only there, right lined winds blow round a central calm space, becoming more and more involute, the nearer they approach its verge: so that the transparent storm cards in general use by sailors, which are drawn in concentric circles, as if founded on the idea of the wind blowing in that manner, do not truly represent the way in which the wind comports itself in revolving storms, and are therefore liable to lead to error, besides puzzling the unexperienced, and giving a false conception of the working of the winds.

The error, however, becomes less appreciable the nearer we approach the margin of the calm centre, where the rapid convergence of the winds may sometimes produce almost the same effect, as if they blew in circular currents.

This difficulty is acknowledged both by Mr. Redfield and Mr. Piddington, who refers to it in his work on Storms at page 88 and 89, under the head of **"probability of the incurving of the winds in a Cyclone."**

> "I should mention here, that, though for convenience sake I have spoken of the wind as blowing in a circle, and the foregoing tables are calculated on that supposition, yet, it is by no means certain that it is a *true* circle, or that even *if* the whole body of the storm be circular, that the winds within it, blow every where in exactly concentric circles. Mr. Redfield on this subject says, in a recent memoir, American Journal of Science and the Arts, Second series, N°. 1. p. 14. — "I have never been able to conceive that the wind in violent storms moves only in circles. On the contrary, a vorticular movement, approaching to that which may be seen in all lesser vortices, aerial or aqueous, appears to be an essential element of their violent and long continued action, of their increased energy towards the centre or axis, and of the accompanying rain.
>
> In conformity with this view, the storm figure on my Chart of the storm of 1830, was directed to be engraved in spiral or involute lines, but this point was yielded for the convenience of the engraver." And, again Mr. Redfield remarks —
>
> "The common idea of rotation in circles, however, is suf-

ficiently correct for practical purposes, and for the construction of diagrams, whether for the use of mariners or for determining between a rotative and a general rectilinear wind, on one hand, or the lately alleged centripetal winds on the other. The degree of vorticular inclination in violent storms must be subject, locally, to great variations; but it is not probable that on an average of the different sides, it ever comes near to forty five degrees from the tangent of a circle, and that such average inclination ever exceeds two points of the compass, may well be doubted."

The facts now mentioned, confirm Mr. Espy's and Professor Hare's theory of the true motion of the wind in revolving storms, as I understand it from Mr. Piddington's work, the only one I have had access to; that Cyclones and Whirlwinds are surrounded by centripetal currents, i. e. straight lined winds, rushing to a central space, around which they blow in tangents.

Admitting the analogy between the smaller whirlwinds, and revolving storms, or Cyclones properly so called, we might expect to find in both cases the air disturbed to a considerable distance beyond the actual circle of gyration or limits of the active portion of the storm; and that such disturbance would be marked by currents of wind converging towards that particular point. This is known to be the case with regard to the smaller whirlwinds; — and the following instances seem to illustrate the same fact on a much larger scale.

Extract from a Meteorological Journal:

Lahore, April 21th 1851. Last night the sky being clear and air still, a great display of shooting stars was observed from 9 to 10, and shortly after, the general direction of which was from N. E. to S. W. Many hundreds passed during that time.

3 A. M. — Air still. No shooting stars visible now. Moon shines bright to S. E. Light masses of Cirri to the N. E. and S. W. hemispheres, stretching in parallel strata or lines S. E. and N. W. which seemed to have moved from the N. E. The Zenith nearly clear.

7h. 30m. A. M. — Air still. Overcast sky. Nimbi arches to the S. W. Vane unsteady.

10h. 30m. A. M. — Air still. Bar: 29.022 att. Ther. 76°, air 80°. To the N. E. hemisphere, large masses of cumulo-strati,

fringed with feathery cirri appear. A few patches of light cirrous scud are seen moving from West to East.

1h. 30m. P. M. — Air still. Vane points to N. E. Whole sky covered with cirro-cumuli and strati. Overhead the clouds in commotion. Three layers of the same description of cloud are observed overlying each other. No lower one, a light scud, at a considerable elevation, two miles or more, moves from West to East. A little above, a bright more massive strata, moves almost equally fast from East to West, while through them is seen, at intervals, a thin layer of white cumuli with no perceptible motion (owing probably to its high elevation).

3h. 45m. P. M. — A light unsteady wind sprung up from the N. W. veering to the N. Sky cloudy.

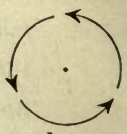
4h. 15m. P. M. — Wind North, rising suddenly, blows in gusts, from the passage of dust whirlwinds. Atmosphere electrical (shewn by sparks from the atmospheric conductor), Sky overcast with nimbi and strati.

6. P. M. — Very stormy looking to the Northern hemisphere. Clear to South. A storm appears in the Northern horizon, distant ten or fifteen miles, the centre of which, bearing about north of the observer, is marked by a dark columnar patch of nimbi, occupying in breadth a space, as far as can be recollected (for this mode of gauging is not entered in the journal) which would be covered by a finger held before the eyes, at the distance of 29 or 30 inches, whence proceed vivid flashes of thready, forked, very irregular lightning. The dark patch, which seems to be the centre of the storm, advances steadily along the distant horizon, and in the course of an hour and half has reached almost to Eastward, and by half past eight, when the sky was clear, the storm was out of sight, though distant lightning still appeared in the East. During the first hour and half, viz. from 6. P. M. to 7, 30, while a light unsteady wind, sometimes increasing in strength, blew from N. by W. and N. N. E., as the storm progressed, a *scud cloud* in light patches, *over head* a mile or more high, *moved* rapidly in an opposite direction, viz: *from South to North, towards the body of the storm, in a line apparently tangent to the outer or advancing verge of the stormy patch, preserving throughout the period here mentioned*

the same relative position — shifting the line of motion as the centre of the storm progressed. Plate 13.

7h. 45m. P. M.— A light wind from N. and N. N. E.; sometimes blowing rather stronger.

8h. 35m. P. M. — Whole sky clear, with the exception of a bank to the N. E. whence lightning continues to play. Light wind from the N. E. One of Jupiter's satellites visible to the naked eye.

It may here be remarked, that the nucleus of the storm,  if one of the revolving kind, rotated probably from right to left, and in accordance with the fact observed with respect to the smaller whirlwinds, the direction of the clouds above during the progress from West to East, may have represented the lengthened centripetal currents of wind, which are believed to blow with increased energy on the side corresponding to the working of the rotation and the line of progression; which set of currents, it may be suggested, when at certain distances from the centre of motion, occupy an elevated position in the atmosphere, overlying a surface current of wind blowing sometimes in an opposite direction, from some cause unexplained.

Capt. Scoresby in describing the variable nature of the winds in the Arctic regions, mentions a case which seems to bear upon this point, and affords an illustration of the rotatory character of such winds, and the direction they assume towards a particular point of excitement.

He remarks: "The phœnomenon that is most calculated to excite surprise is, that several distinct and even opposite winds, with the force, in many instances, of a fresh gale, will occasionally prevail at the same moment of time, within the range of the horizon." He continues: "It sometimes happens, that ships, within sight of each other, will, at the same period of time, experience every variety of weather, from calm to storm, from fair weather to thickest snow, together with several distinct and contrary currents of wind. On the morning of the 30th of April 1810, the ship Resolution, in which I served in the capacity of Chief mate or harpooner, was, during thick showers of snow, sailing by the edge of a stream of ice, with the wind from the North-Westward. About ten, A. M., the snow abated, and several ships were seen within the distance of three or

four miles. As all of these ships were sailing "on a wind", it was easy to ascertain the direction of the wind where they were, and curious to observe its variableness.

Two ships, bearing North-East from us, had the wind at North-East; two, bearing East, had East or East-North-East; two bearing South-East, had the wind at South-East; while, with us, it blew from the North-West. In each of these situations, a fresh breeze prevailed; but in some situations, where there happened to be no ships, there appeared to be no wind at all. The clouds above us, at the time, were constantly changing their forms — showers of snow were seen in various places at a distance."

The accompanying diagram drawn to scale is intended to illustrate this description. Plate 15.

A small roundish dense white cloud, occasionally presents itself suddenly on a clear sky.

On first witnessing it at Lahore, I supposed it to be a shrapnell shell burst in midair, and waited to hear the report. Its gradual enlargement soon shewed what it was. Another time, the cloud trailed along with it to the earth, a faint slate grey streamer. — Its true nature was then apparent, viz, an Electrical column passing over water and forming, for the time, a diminutive Water spout.

Capt. Scoresby relates a case somewhat analogous, which may be taken to show, that partial and sudden gusts of wind, which we now know are occasioned by the passage of the Electrical spiral through the air, are not confined to the earth's surface, but are met with blowing with equal force in very elevated regions. His father while

"engaged admiring the extensive prospect from an eminence in Charles' island, of about two thousand feet, scarcely noticed the advance of a very small cloud. Its rapid approach and peculiar form (having somewhat the appearance of a hand) at length excited his attention, and when it reached the place where he was seated in a calm air, a torrent of wind assailed him with such violence, that he was obliged to throw himself on his body, and stick his hands and feet in the snow to prevent himself from being hurled over the tremendous slope which threatened his instant destruction. The cloud having passed, the air, to his great satisfaction, became calm, when he im-

mediately descended by sliding down the surface of snow, and in a few minutes reached the base of the mountain in safety."

In 1851, a Storm Card, founded on the presumption that the winds in a Cyclone blow round a central space in tangents, was proposed, and a brief description of it published in the Bengal Asiatic Journal.

Mature consideration favours the belief, that this is the true principle on which such a card should be drawn. But in as much as the size of the central space in Cyclones is liable to endless diversity — the circle at one time expanding — at another contracting — subject also to an acceleration and retardation in the speed — it is evident that no one card could be constructed so as to meet every case: the seaman should, therefore, make his own cards to suit the emergency, which he may easily do with tracing paper.

To meet the difficulty, I now propose, by way of illustration, to draw a card with three circles, representing the respective diameters of three different sized Cyclones — each one surounded by its own tangent winds, delineated so as to avoid confusion — the true direction of the winds, in each circle of tangents, being marked on a corresponding marginal rim. One card, if need be, is applicable to both hemispheres, by reversing it. The accompanying figure of a Storm Card, is drawn to scale, with circles of 50, 84 and 124 miles in diameter respectively, to suit the chart of the *Charles Heddle* Cyclone in 1845, so skilfully worked out by Mr. *Piddington*, and published in his Horn, Book, as also in the Nautical Magazine of 1846, which chart is here introduced, marked with some of the ship's courses prolonged in tangent lines, to shew the direction of the winds, as they occurred in succesSsion, while the vessel was carried round and round several times in the vortex.

As this chart is supposed to give an admirable illustration of the working of a Cyclone in the *Southern* Hemisphere, it may be granted, that the value of the proposed card will be fairly tested by being made to apply to it, due allowance being made for slight errors in the construction of the original chart, and for the possibility of the centre of the Cyclone not having been laid down with perfect accuracy between the 22nd and 25th, and also on the 27th. The ship's courses in consequence being marked somewhat out of their proper places.

During the first 24 hours, the Cyclone appears to have been almost stationary, progressing at the rate of about a mile an hour. After

that it moved more rapidly, and by the 25th had contracted its diameter considerably, and continued its rotation with more uniformity.

The Card, it will be observed, is constructed on the supposition that the Cyclone, when perfectly formed, preserves the integrity of its circular or cycloidal gyration throughout — though, as before mentioned, the active forces of the storm are augmented on the side of progression, which it is manifest they were in this case, by the longer courses swept by the ship, when drifting in that particular portion of the storm; a circumstance that seems to favour the correctness of the principle upon which the Card is constructed — but it is safer to leave its further elucidation to those acquainted with Nautical science.

A Cyclone Compass was also constructed and a description of it given in 1851 — but, as that, though made on correct principles, is of no practical use to the mariner, no further notice will be taken of it.

On inspecting the Card, it will be observed that the tangent lines representing the winds blowing round the Cyclone, differ considerably, both in direction, and in their duration or length, according to the areas described by the circles of gyration, — and that the length of the lines are made to differ, in order to accord with the supposition, that the vorticular power of the whirlwind is generally increased in proportion to its concentration and consequent diminution, under certain limitations; the concentration being usually accompanied with increased and extended influence on the surrounding atmosphere.

The lines may, therefore, serve to mark the comparative stength and prolongation of the winds blowing round the area of storms of different magnitudes — but in using the diagram, due regard must be had to what has been frequently dwelt upon, viz: that the forces of the whirlwind are greater on the side of progression, and the winds, therefore, on that side of the storm are greatly prolonged and their power augmented.

Plate 17 represents transparent Horncards for the Northern and Southern hemispheres, with tangent wind lines marked for two different sized Cyclones only, to avoid confusion from intersecting lines.

A representation is also given of ships standing on their proper tacks to escape running into the centre.

It is supposed, that this so completely simplifies the thing, as to afford to the sailor at a glance, a knowledge of where abouts he is,

and what he has to do, when involved in a storm of the kind; which cannot be said of the Horn-Cards now in use, which are drawn as if on the erroneous supposition, that the wind in a revolving storm blew round and round in concentric circles.

Much interest is connected with an inquiry into the origin and termination of Cyclones. The cause of their rotations and progressive motions; — what can become of the enomous volume of air, which is driven in all round the vortex; and how the mysterious calm centre is to be explained.

According to the testimony of Mr. Piddington in 1851, none of these phœnomena have been satisfactorily accounted for: and the difficulties attending their explanation are best known to those who have devoted most attention to the study.

Mr. Piddington, at pag. 279 of his book on Storms for 1851, referring to how Cyclones begin and end, remarks:

> "we are yet involved in utter mystery as to these two essentials to the history and right understanding of Cyclones." None of our researches have as yet disclosed to us anything on this subject beyond remote conjectures"

and, referring to the cause of their rotations he says:

> "there is another great law, which is wholly unaccounted for by either of them, and this is the: **Law of their rotation**; so invariable in each hemisphere, that we find nothing approaching to a doubt of it in all the numerous investigations which have been made;" —

and as to their *progressive* motions, pag. 71:

> "We are thus as yet entirely in the dark as to what causes their progressive motion, as we really are as to what gives them their violent gyrations; and we are still more so, if we consider that like sand-storms or dust whirlwinds, some of them appear to remain comparatively stationary for hours, or a day or more (vide pag. 37) moving at a rate of 1½ or 2 miles an hour, and then to start off, as it were, on a track upon which their size and velocity gradually increase! We find them also usually much diminished in their velocity when they pass over land, especially if it be high, and it would appear too that

storms sometimes *decrease* in size and in rate of travelling, but augment fearfully in so doing, their violence; and this, when passing over the open ocean. It is then quite impossible to say to what their progression is owing."

There is no explanation given to account satisfactorily for, what is commonly called, the calm centre, nor what becomes "of the huge volume of air which must be every moment poured in to supply the forces of the Cyclone;" pag. 290.

Without attempting a lengthened discussion, which must be left to others more competent to do justice to the subject, I shall confine my attention to certain facts and principles, upon the right interpretation of which, most of the phœnomena now before us, may admit of solution. And first I would point to the Electro-Magnetic Spiral Column which seems to be a *key* to the whole; — representing, as it does, a mysterious presiding agency — we might almost say, *animated* — itself endued with motion, and capable of imparting it to other matter with which it may be brought into contact; involving it, and bodies of a similar nature to itself, in its own vorticular revolutions.

This property of matter has been ably set forth by the late Sir Richard Phillips in certain axioms, as they may be called, on the cause of circular motion, — (ascribable, as he asserts, to action and reaction in opposite directions in a medium; which thus becomes a "transmitter of the forces,") some of which are here quoted.

1. "Action and reaction are always equal, and in directions varying as the angle of impulse."

2. "Small bodies are moved by large ones, because involved in their motion."

3. "It is a principle never to be lost sight of, that circular motion is a necessary result of equal action and reaction in contrary directions."

4. "It would be the effect of the reactions of such media (air, water &c.) to make bodies of certain sizes and distances go round each other, when moving *contrary ways*, and approximately only *when moving the same way*."

5. "There cannot be a reasonable doubt that all circular motion in nature is the effect of action and reaction."

6. "If a progressive motion acted alone on a mass, it would form a train of the rarer parts, and *disperse* them. If a rotative

motion acted alone, it would direct the parts in tangents and *disperse* them. Their combination direct the parts to the centre, and the two become a force of aggregation, centripetal force, gravity, or weight."

7. "In the gaseous state, the atoms are projected, and then repelled into orbits by the atmospheric pressure, and maintain a space or volume by re-action; for all projectiles, uniformly re-acted on, are converted into orbit motions."

8. "When one body moves another body, their subsequent velocity is lowered as their joint mass is inereased. Large bodies move small ones by division of velocity, often miscalled re-action."

9. "Bodies have no force or momentum but what they derive from some transferred motion of another body in motion."

Bearing in mind, therefore, the facts already detailed concerning the physical properties of the whirlwind column, and applying to it the above fundamental rules of science, as far as they will go, we perceive one way in which the Cyclone sometimes does commence.

A few spiral columns descend from the sky to the surface in the form of water spouts or dust whirlwinds — which, by degrees, exert an influence on the adjacent air, above and below, — causing by their rotatory movements, vorticular currents all around, — involving by that means, other bodies of a similar nature; — till, at length, by fresh accessions, the area of revolution is so enlarged, that from a whirl of only a few yards in extent, it comes to measure many miles.

Another way. A Tornado or Dust-Storm, which we know to be a right lined tempest, may gradually, by means of friction, be deflected, and finally converted into one of a revolving character, increasing in size, as it acquires a revolving motion, by fresh additions from the surrounding atmosphere. Again — Numerous spiral columns, thousands of which, during 6 or 7 hours of the day, are continually passing, and on other days repassing, as if a host was mustering for the battle, — after accumulating somewhere and somehow, may return, as a compact body, and "rank upon rank, rank upon rank", like an army in motion, rush swiftly over the ground, as a Tornado or Dust-Storm, and become converted, as in the former case, into a Cyclone or revolving storm.

As regards the *Calm Centre*, — the case is plain. What is true of the whirlwind of small diameter, is equally true of one of much

greater dimensions; both are influenced by the same laws, and a central space, devoid of *wind*, is a necessary effect of centrifugal forces and vorticular movements of the Tempest, but, *not*, as some suppose, by reason of the *conflicting, and opposing winds neutralizing one another*, thereabouts.

The cause of the opposite rotation of the Cyclones in the two hemispheres is explained (to my notion) in Part 2, where it is ascribed to the configuration of the Earth, and the two motions it is subjected to, — the diurnal, on its axis, — and the impetus with which it is carried on in space; directing the motions or currents of the atmosphere, and matter floating in it, of which the whirlwinds are composed.

The idea is supported by the analogy of two vortices in a fluid, rotating in opposite directions when disturbed by a body moved in it in a definite direction; especially when that body is *convex;* the two vortices will then, acquire a curve left and right, corresponding to what we conceive may be the effect of the *first impetus*, communicated to the Cyclones in the Northern and Southern Hemispheres, before they recurve backwards N.W. and S.W.

The ascensive power, or upward spiral movement of the whirlwind column, as displayed in a continual transference of dust or watery particles from the earth to the sky, enables us to explain what becomes of the immense influx of air, which continues to press in from all sides around the vortex.

The vast body of air driven inwards, does not, I conceive, move like „a huge moving chimney-like column," though the effect may be nearly the same — but is got rid of, by the instrumentality of the *individual* spirals, — each spiral column disposing of its own air.

What becomes of the Cyclones, is a more difficult question to answer. As they descend, so in like manner, they may again ascend to their own elevated region; — not bodily, perhaps, but possibly by degrees, as we have seen them form; and, as we know, the smaller whirlwinds have been seen to decrease. Or, they may (after running their accustomed parabolic tracts, N. West, and then in continuation, wheeling to N. East, in the *Northern Hemisphere*, acording to Mr. Redfield, Col. Sir W. Reid, Mr. Milne &c. or in the *Southern Hemisphere* — S. West, and whirling round again to S. East, according to Reid, Dr. A. Thom, Mr. Bousquet, Mr. Piddington and others) on approaching the poles, become absorbed into the beautiful *Aurora*.

It may be asked — are the whirlwind columns confined to Tropical climates, since they are not observed in these more Northern latitudes. In answer to such an inquiry, I may confidently affirm that they do exist equally in these temperate climes, as well as in the Tropics; though from the humid state of the atmosphere, and cultivated soil, and the subdued power of the sun's rays, the conditions favourable to their *visible* development are not present, and accordingly they pass us unnoticed. Still, there they are; and not a change of wind or weather occurs, but it is accompanied by a manifestation of these very spiral columns, — unseen, however, save at the moment of their passage, when the dust whirls along the ground in eddies hither and thither, and marks as it were the *foot print of the spiral column.*

To an unpractised eye, these eddies convey little or no meaning; but to those who have been continually exercised in observing such phœnomena, under every aspect, they are full of meaning — and lead to the conclusion, that the self same causes of wind exist all over the world.

On viewing Plate 2 & 11, which are intended to illustrate the current of air drawn into the vortex of the whirlwind column, we cannot fail to be struck with the resemblance they bear to the figures of comets.

So striking indeed is the resemblance, that it well might lead to the supposition, that the two phœnomena were influenced by the very same laws; and that the tail of the comet was due to the same kind of action and reaction on a surrounding medium, through which it passes, as in the case of the whirlwind column.

On a closer inquiry, the analogy is still more marked.

Both possess rotatory and progressive motions in a medium; and the whirlwind, under certain favourable circumstances, throws out a tail, as the comet does, on the side of progression, which points away from the centre round which it would revolve; (that is, when the direction of its progress is the same with that of the rotation) always preserving the rotative position in whatever part of the circle it may occupy. If the rotation is the contrary way, the tail is developed on the opposite side.

To what distance these side currents of the whirlwind extend, is not known. That seems to depend upon the velocity and rotative energy of the spiral column, as is said to be the case with comets; the dust, however, has been observed to be strongly affected at right angles to the line of progression, to the distance of 50 yards or more, I think, when the area of the vortex, or whirling circle, has been about 3 or 4 yards in diameter — but the air may be affected to a much further extent.

It may, therefore, be suggested, that the tail and luminous atmosphere of comets is occasioned by the effect of the rotatory and progressive motions of the body, in the ethereal medium: and the influx of matter, which must necessarily take place, as in the case of the whirlwind, may be disposed of in something of a similar way, and give rise to the appearance of concentric coats, clearly marked in some cases.

Sir John Herschel's description of some of the most remarkable characteristics of comets, will be read with increased interest.

"Par. 561. Their variations in apparent size during the time they continue visible, are no less remarkable than those of their velocity; sometimes they make their first appearance as faint and slow moving objects, with little or no tail; but by degrees accelerate, enlarge, and throw out, from them this appendage, which increases in length and brightness till (as always happens in such cases) they approach the sun, and are lost iu his beams. It is for the most part after thus passing the sun, that they shine forth in all their splendour, and that their tails acquire their greatest length and development; indicating, may be, the increased action that has been communicated to them by their close approximation to that luminary."

"As they continue to recede from the sun, their motion diminishes, and the tail dies away, or is absorbed into the head, which itself grows continually feebler, and is, at length, altogether lost sight of, in by far the greater number of cases never to be seen more."

"Par. 599. It is, however, in a physical point of view that these bodies offer the greatest stimulus to our curiosity. There is, beyond question, some profound secret and mystery of nature concerned in the phœnomena of their tails. Perhaps it is not too much to hope, that future observation, borrowing every aid from rational speculation, grounded on the progress of physical science generally, (especially those branches of it which relate to the etherial or imponderable elements) may ere long enable us to penetrate this mystery, and to declare whether it is really *matter*, in the ordinary acceptation of the term, which is projected from their heads with such extravagant velocity, and if not impelled, at least *directed* in its course by a reference to the sun, as its point of avoidance. In no respect is the question as to the materiality of the tail more forcibly pressed on us for consideration, than in that of the enormous sweep which it makes round the sun in perihelio, in the manner of a straight or rigid rod, in defiance of the law of gravitation, nay, even of the received laws of motion, extending (as we have seen in the comets of 1680 and 1843) from near the sun's surface to the earth's orbit, yet whirled round unbroken; in the latter case through an angle of 180° in little more than

two hours. It seems utterly incredible that in such a case it is one and the same material object which is thus brandished. If there could be conceived such a thing as a *negative shadow*, a momentary impression made upon the luminiferous œther behind the comet, this would represent in some degree the conception such a phœnomenon irresistibly calls up. But this is not all. Even such an extraordinary excitement of the œther, conceive it as we will, will afford no account of the projection of of lateral streamers; of the effusion of light from the nucleus of a comet towards the sun; and its subsequent rejection; of the irregular and capricious mode in which that effusion has been seen to take place; none, of the clear indications of alternate evaporation and condensation going on in the immense regions of space occupied by the tail and coma, — none, in short, of innumerable other facts which link themselves with almost equally irresistible cogency to our ordinary notions of matter and force." *Sir John Herschel's* Outlines of Astron^y.

The following interesting account of a remarkable natural phœnomenon bears upon the subject under discussion.

The writer is a Mr. Mc. Murray, a gentleman employed as an Agent of the British & Foreign Bible Society in the West Indies and South America.

"On the twenty-seventh of April we had passed a pleasant day, and were beginning to guess at the probable time of our arrival at the mouth of the Delaware. In the afternoon of that day, the sky became suddenly overcast, and presented a conflicting and angry appearance, which led me to express my fears to the Captain that we were going to have a "blow." He thought otherwise, but continued to gaze on the various strata of clouds which seemed to be meeting, and circling, and mustering, as if preparing for the display of some extraordinary phœnomena. Soon after this, our attention was called to two large water-spouts, which were approaching us with a speed of from fifteen or twenty miles an hour, while our progress at the time did not exceed two. With feelings of delight, we gazed upon them, as they crossed our bows within pistol shot, making the surface of the water as they passed, for a space of a hundred square feet, boil and steam like an immense furnace. Soon after this, the air was completely darkened, and night came on.

The wind was now so light and changeable, that the Captain ordered most of our sails to be furled. The thunder was terrific, and the flashes of lightning so frequent, and so vivid, as completely to illumine the thick darkness in which we were enveloped. The water spouts that we beheld and admired, with the light of the day, were but the prelude to the awfully grand scene that now opened to our view. The rushing noise of the water spouts around us, was appalling, whilst their position and progress were revealed to us by the lurid glare of the lightning, and by flaming meteors, which like blazing cannon swept a curve in the distance. — The columnar form of the spouts thus exhibited, perpendicular, or slightly inclined, as they were stationary or progressive, seemed to support the canopy of blackness, that was spread over and around us. The scene, could it have been viewed without feelings of the utmost

apprehension, was one the most magnificent, that language could describe, or the imagination could paint. But having no other cargo, than seventy five tons of iron, which was hardly sufficient to balast our flat-bottomed barque, we expected every moment to be struck by the lightning or to be capsized by a water spout.

In the midst of these trying circumstances, the attention of all on board was called to five or six water spouts, on our starboard quarter, and by the aid of the lightning's glare, we endeavoured to mark their progress, and their path. Instantly the alarm was given, that one was close to us on the other side, which was approaching us with a speed and a rushing sound, that threatened instant destruction. The Captain at the top of his voice called out: "Let go the halliards!" "Haul down the jib!" the men were at their post, and yet before they could obey the order, the water spout was upon us; it struck us midships and gave us such a lift, we thought we were gone. What an anxious moment! The past, the present, and the future crowded on the mind with a force, that to be comprehended must be experienced. As the spouts have a rotatory as well as a progressive motion, by the former having crossed us, it struck the ship on the lee side, and assisted us to right again.

For four anxious hours we were in this helpless and pitiful condition," deep calling unto deep," — at the noise of the waterspout" (pipes) during which time no fewer than twenty-five were made visible to us by the lightning's flash. It was with the feelings of the liveliest gratitude to God, that I read on the following morning the 107th Psalm. Scarcely had I finished the reading of my daily portion, when our attention was arrested by the appearance of the clouds, and in a few minutes after, six huge water spouts formed, the largest of which was nearest to us, and all but stationary; it was about three furlongs off. Had we been visited, becalmed as we were, by one so large, and whose progress was so slow, we could not have escaped a watery grave."

"I may just mention, that these electrical phœnomena so frequently witnessed by mariners in the Gulf stream, are no

doubt in a great measure to be accounted for by the fact, that the waters of the stream heated within the tropics, are of a temperature of 8° to 10° Fahr. above those on either edge"

Calcutta Oriental Baptist, for April, 1850.

The following communication made to me in 1853 by Capt. Geldhart, of the Bengal Army, on the Electricity developed in Dust Storms, with a description of an arrangement used by him for the purpose of testing the phœnemenon is here introduced. (See Plate 16.)

A 30 foot pole, was fixed on the flat roof of a house, in which he resided, which carried a 5 pronged insulated brass fork, to which was attached an atmospheric exploring wire, which was brought through the roof into his sitting room, and there connected with several unmagnetized needles suspended in coils — and a table on which were placed cups containing saturated solution of zinc, copper, and acidulated water — all connected together — and terminating in a conductor connected with the earth.

Capt. G. states:

"one evening about half past five, a violent Dust Storm blew from the N. & N. W. The rod of my apparatus being down, no Electricity was at first perceptible. On raising the wire *a* proceeding from *M.* and its opposite wire, and plate *b*, to ascertain if any deposit had taken place, and finding none, I approximated *a* and *b*, when instantly the angle of *b* was fused with a hissing noise. Not knowing what might happen next, I quickly immersed each wire again in the cup and broke the circuit at *M.* A stream of vivid blue, the thickness of a crow quill, and ½ an inch or more in length, now passed between *M.* and the wire *a*, which I held in my hand. I united them without delay, fearing an accident, being warned of the enormous quantity of Electricity that was passing at the time, by observing the heliacal coil and frame *G.* covered with a lambent flame, while occasional sparks sprung from the wire *C.*

Having placed *H.* about ½ an inch from the ball on *J.* and disconnected *M.* with *N. O. P. Q.*, I retreated into an inner room, and there sat watching. — From time to time, sparks flew about the room, particularly in the direction of an Iron rod suspended from

the ceiling by ropes, over the table, which was used to hang clothes upon. — Very large sparks passed at first at intervals; the balls being kept far apart, it took some quantity of Electricity (or time) to charge the brass rod and ball *H.* (which was of some thickness) before the discharge took place. During the time the storm was passing over the house, the sparks become so frequent, and the apparatus so highly charged, that the electrical discharge finally settled into a most vivid star brush which lasted nearly an hour. — From the point of the needles, which

together with the piece of soft iron suspended in the Helices, remained unmagnetized, issued a sharp wind or *Aura*, with a hissing noise, which pierced the hands on approaching them, like needles, and which lasted throughout the storm, increasing or diminishing according to the intensity of the electrical discharge.

The needles were attracted to the sides of the helix; but, the soft iron was unaffected, while a *new steel file* lying on the table at the distance of several feet, was afterwards found magnetized.

When the storm had nearly blown over and a comparatively small Electrical discharge was passing, I made the current pass through a coil machine, *with* and *without* the bundle of wires, yet no effect was produced on an Electrometer.

The spark that then issued, was considerably greater than what is elicited from my battery of 6 oz. cells, affording a surface of metal amounting to 216 square inches.

Another time, in presence of Capt. Gastrell, I placed a horse-shoe of soft iron in a Helix, and made it form the circuit of the atmospheric wire — when I found, that throughout the day it was magnetic and would lift 2 or 3 ozs. — Its greatest power was found to be about 2 & 3 P. M. after which it decreased; and by 7, 8 and 10 P. M. it would with difficulty carry the armature — a very small piece of iron 2 inches long, by $\frac{1}{8}$ of an inch square.

The amount of Electricity developed, was found to be in proportion to the height of the atmospheric wire."

The explanation of the cause of wind now advanced, differs so entirely from any received theory on the subject, and is so little known in Europe, that it seems necessary in the present essay, as a kind of guarantee to its notice, to furnish the scientific opinions already expressed in India concerning it; at least concerning the first part of the investigations, having reference chiefly to the electric origin of Dust Storms.

In the addenda to Mr. Piddington's work on the Law of Storms, Ed. 1851, is the following remark:

„In the Philosophical Magazine for August 1850, N°. 248, is a highly interesting paper by Dr. P. Baddeley H. C. S. dated from Lahore, shewing conclusively, by electric experiments extending over the hot seasons of 1847, 48, 49 and 50, that the Dust Storms so prevalent in all the North-Western Provinces of India in the dry months are purely electrical. The passages marked in italics are so by myself, as exactly coinciding with the views I have submitted since the first edition of this work."

"Dr. Baddeley's observations, however, do much towards the advancement of the theory of an electric origin for Cyclones of all sizes and classes, and I trust they will be continued."

In the Bengal Asiatic Society's Journal for 1851, is the following notice:

„The Editor reprints this paper with great pleasure; not only as another of those triumphs of Indian research, which have so often adorned the pages of this journal, and so well demonstrated to the scientific world what the energy of English minds alone can perform, under all the discouragements and difficulties, which the experimental sciences particularly must meet with at every step in a state of society so peculiar as that of India, but, moreover, as a solution of a great meteorological problem which opens a new page of the Book of Nature, in that vast and yet unwrought mine of Science. We trust that Dr. Baddeley will continue his valuable researches in the great field which he has before him — Ed. Jour" — of the Bengal Asiatic Society for 1851", and again —

From the Delhi Advertiser, March 4. 1853.

"We were led to take up the book, desiring to gain some information on a subject which, though so worthy of investiga-

tion, would appear hitherto to have been entirely overlooked by all philosophical and scientific men.

We have perused the volume with extreme pleasure — and trust with profit too. The new theory of the origin of winds propounded by Dr. Baddeley — which we fancy has never before been so much as even surmised, will not, in all probability, be received at first with that degree of consideration to which it is most undoubtedly entitled — since it militates so completely against all accepted theories on the subject. The author states his opinions clearly and concisely; and we do hope his researches, which are so eminently praiseworthy — will stimulate others — equally zealous of promoting science, to prosecute enquiries into this new field of nature's handiwork &. &."

The following note is from the late Dr. Fred. Corbyn (of revered memory) superintending Surgeon of the Punjab — formerly Ed. of the Indian journal of Medical and Physical Science — to whom might be justly applied the saying — "an Israelite indeed, in whom is no guile."

Jullundar, 5. Nov. 1850.

My dear B.

Your first communication regarding electric currents in Dust Storms was first received by me in your Annual Report from Ferozpore 1847, to which I called particular attention in my official report. You have maintained and dwelt upon the views ever since — indeed, the apparatus you had subsequently placed in your quarters at Lahore, I understood from you, was with the view of ascertaining, or rather, confirming the influence of electricity in these storms.

Believe me, sincerely Yours

Fred. Corbyn.

The following passage appears in a letter from Mr. Piddington, Author of „the Sailor's Horn Book for the Law of Storms"

Calcutta 22 Oct. 1850.

I take the liberty of congratulating you most heartily on the splendid discovery you have made, and do so the more earnestly, as you will see, that 11 years ago, I tried to direct the attention of Mofussil Residents to whirlwinds in general, and to their probably electrical origin; and that in 1848, I published in the Sailor's Horn Book the hypothesis, that the Cyclone, is an electric

meteor composed of one or many close and nearly horizontal, but yet slightly spiral streams of electric fluid, descending thus from the higher regions, and in its (or their) descent, giving rise to currents in all the air it necessarily passes through, but not carrying this same air along with it. Perhaps, however, you have the book? but in the mean time, allow me to thank you very earnestly for the great step you have made for us."

* Mr. Piddington's work had not been seen, nor any other one on Storms, till Mr. P. did me the kindness to send me a copy of his last Ed. for 1851.

PART II.

Part 2 consists chiefly of a reprint, with some corrections, of original papers, and exhibits the progressive steps pursued in the present inquiry, and furnishes data upon which the theory of Wind, now proposed, is founded.

The substance of the following letter, (the first of its kind) was published in the London Philosophical Magazine for August 1850.

Lahore, April 18th. 1850.

"My observations on Dust Storms, which are very prevalent in this part of India during the dry months, April, May, and June, before the setting in of the rainy season, have extended as far back as the summer of 1847, and the result is as follows.

Dust Storms or Whirlwinds, are caused by spiral columns of the electric fluid *) passing from the atmosphere to the earth; they have an onward motion, a revolving motion, and a particular spiral motion from above downwards, like a corkscrew.

It seems probable that in an extensive Dust Storm there are many of these columns moving on together in the same direction; and during the continuance of the storm, sudden gusts take place at intervals, at which time the electric tension is at its maximum.

Precisely the same phœnomena, in kind, are observable in all cases of Dust Storms and Whirlwinds; from those of a few feet in diameter, to those that extend for 50 miles and upwards, the phœnomena are identical.

It is a curious fact, that some of the smaller Whirlwinds occasionally seen in extensive and arid plains, both in this country and in Affghanistan, appear stationary for a long time during which, the

*) The supposition has been modified since this was written in 1850.

dust and light bodies on the ground are kept whirling above into the air. Sometimes, these small Dust Whirlwinds are seen slowly advancing, and when numerous, usually proceed in the same direction. Birds, such as Kites and Vultures, are often seen soaring high up, just above and around these spots, apparently following the direction of the column, as if enjoying it.

My idea is, that the phœnomena connected with Dust Storms, are identical with those present in water spouts and squalls at sea, and revolving storms and tornadoes of all kinds, and that they originate in the same cause, viz, in moving columns of electricity.

In 1847, at Lahore, being desirous of experimenting on the electrical state of the atmosphere, I projected into the air an insulated copper wire on a bamboo on the top of my house, and brought the wire into my room, and connected it with a gold-leaf electrometer and a detached wire communicating with the earth. A day or two after, during the passage of a small Dust Storm, I had the pleasure of observing the electric fluid passing in vivid sparks from one wire to another, and of course, strongly affecting the electrometer. The thing was now explained; and since then, I have, by the same means, observed at least sixty Dust Storms of various sizes, all presenting the same phœnomena in kind.

I have commonly observed that towards the close of a storm of this kind, a fall of rain suddenly takes place, and instantly the stream of electricity ceases, or is much diminished; and when it continues, it seems only on occasions, when the storm is severe and blows for some time after.

The sparks, or the stream of electricity, as it is seen passing from one wire to the other, is in some cases, and during high tension, doubled or trebled and is never straight, but invariably more or less crooked.

Various kinds of sparks are seen; at times, one end of the wire has a star; and from the wire, when held just beyond striking distance, a luminous brush is seen curved, which, when viewed through a lens, seems composed of a stream or cascade of bright globules, like a shower of mercury when pressed through leather.

The electric fluid streams down the conducting wire, unremittingly during the continuance of the storm; the spark is oftentimes upwards of an inch in length, and emits a crackling sound; its intensity varying with the force of the storm, and most intense, during the squalls or gusts.

The instant the insulated wire is involved in the electric current, marked by the column of dust, down streams the electricity.

One day I caused the current to pass through a solution of cyanide of silver, so as to affect a small flat piece of copper wire, which was rapidly covered with a coating of silver, which upon drying, peeled off. In this case, the cyanide of silver was pure, formed by the precipitation of the nitrate of silver by prussic acid, and the precipitate redissolved in the same menstruum.

In subsequent attempts to silver a wire or coin in this way, I have not succeeded; only a very slight deposit taking place, which was not increased by long exposure to the influence — but it must be noticed that in all other trials, the cyanide of silver was dissolved in cyanide of potassium: In the course of time, minute whitish bright crystals formed on the surface of the metal."

The small insulated copper wire used on this occasion, was found some weeks after, to have undergone a curious change, whereby it had become brittle and crystalline — the fractured extremities presenting the same appearance as is exhibited when some kinds of iron are broken short off.

The mean height of the Barometric column at Lahore, obtained by summing up the mean monthly result for the month of May, June, July, August, September and October 1851, from daily observations at 10 A. M. and 4 P. M. — the periods of Max^{m}. and Mini^{m}. and taking the *mean* of *that*, when corrected for temperature &c. was, 28,966; from which the height of Lahore above the level of the sea may be estimated *) — vide *Meteorol. Table.*

During February and March 1851, while engaged in the investigation of Dust Whirlwinds, I twice witnessed a curious fact, which seems to throw considerable light upon the complicated phœnomena of storms.

In following upon horse back, a Dust Whirlwind, I observed that as it passed various objects in its progress, such as tents, horses &c. it gradually diminished in size, till at length, instead of a whirling circle of 5 or 6 feet in diameter, composed of several rotating eddies or spirals of dust, as before seen, it terminated in a single cone, the apex

*) In the original communication published in the Phil. Magazine in August 1850, an error occurs in the estimation of the height of Lahore, owing to the use of a defective Barometer.

of which, in contact with the earth, rotated briskly like a top, from left to right, as did the whirling circle before, of which this was a portion.

From the cone of dust, a long ribband-like band, about 12 inches in diameter, of equal dimensions throughout, as far as the eye could reach, was seen to extend into the atmosphere, and from the circumstance of its sides presenting a greater opacity than the central portion, I concluded it was cylindrical. This band was rendered faintly visible by the dust it had whirled up, which by the light of the sun that shone through it, exhibited a kind of vermicular spiral motion. At the height of several feet above the surface of the ground, the slender column formed a spiral turn, still preserving unimpaired its cylindrical appearance, and extending upwards and forwards in advance of the whirling cone. Plate 1.

Suddenly the cone, which had to the last continued to rotate, vanished from the earth, and the whole column then slowly receded upwards and onwards out of sight.

The diminutive Whirlwind is, I conceive, a miniature representation of a Cyclone, and this slender column or pillar seems to indicate the ultimate thread, as it were, of the electrically charged spiral body of which it is composed.

Whirlwinds of all sizes, appear to be composed of a number of electrically charged spiral threads, placed singly, or in fasciculi, each and all rotating independently, as the whirlwind circles onwards in its course; and the incurving of the dust, observable when the body passes over a light dry soil, is occasioned by the rotation of these separate threads. Plate 2.

The rotation of the spirals, may now enable us to comprehend a singular appearance sometimes observed in an approaching Dust-Storm.

A rounded mass, or cloud, of dust, extending high into the atmosphere, is seen to be composed of a number of large vertical columns, each column preserving its respective position in the moving cloud, and rotating on its own axis.

This extraordinary appearance is doubtless occasioned by the advance of a large body of electrically charged whirlwind columns, impelled onwards with the body of the storm: and it may actually represent the exciting element of a Huricane or Cyclone. Plate 8 & 9.

The gusts or squalls that occur from time to time during a storm of this description, may be accounted for by supposing the passage of

a succession of these electrically excited whirling columns; for it has been repeatedly proved, that during the squalls that mark these storms, the electrical tension is at its maximum, since the Electric current streams most furiously down the insulated wire, exactly in accordance with the violence of the wind or gusts passing at the time.

The passage of the electrical column or spiral, through the air, sets it in motion, and causes a wind to blow in the direction of its track, with more or less velocity, depending, seemingly, upon the rapidity of the passage, and the electrical tension of the spiral itself. *Hence, I conceive, that the spirals are the exciting cause of wind in storms; of the gusts or squalls in particular; and of wind generally.*

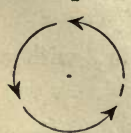
The motive power in the Cyclone, therefore, may be a zone of whirlwind columns, composed of innumerable spiral bodies single and compound, placed at intervals, and rotating with the body of the storm; — first, from above, downwards; secondly, on meeting the earth's surface, whirling their cycloidal courses, with the vortex of the storm, in conformity to laws regulating the motions of fluids in a resisting medium.

Outside this whirling zone, or vortex, centripetal winds exist, blowing from a circumference more or less extended, to the edge all round, as in the case of the smaller whirlwinds.

These centripetal winds, may, to all intents and effects on ships at sea, be considered straight-lined winds, though they are doubtless more or less involute, and the nearer they approach the vortex, the more marked these incurving currents become.

They blow, I believe, with greater regularity, force, and longer duration on the side of the storm's progression; having on that side, a double set of forces acting upon the atmosphere — the progressive and the rotatory.

This side, so important to be determined with certainty, may be known, when the direction in which the storm is moving has first been ascertained, by attending to the law of rotation that prevails in the two hemispheres, viz, that storms North of the Equator, rotate from right to left,

 and those South of the Equator, from left to right.

Having therefore discovered the probable track of a storm, face

the point to which the storm is supposed to be travelling; the stronger centripetal winds will then be found blowing on the *right hand* in the Northern Hemisphere — and on the *left hand* in the Southern.

These stronger centripetal winds on the side of progression, must, for the reason stated, blow more or less in the same direction as the storm; while those on the opposite side of the vortex, will be opposed to it, and much limited in extent.

To illustrate the motions of progression and rotation as observed in the Cyclone, — spin a Tee-to-tum provided with a glass tube drawn to a fine point, containing ink, to the right hand or to left, on paper laid perfectly flat on the table. — The toy will be found to describe a variety of cycloidal courses, imitating exactly the rotations of the whirlwind in the two hemispheres, as also its onward movement in some definite course.

An attempt may be made to explain the law of rotation of the two hemispheres, thus — Owing to the spheroidal figure of the earth, and the two motions it is subjected to, — rotation on its axis, and translation in space, its centrifugal action gradually declines from the Equator (where alone it is uniform) to the Poles, and matter floating in the atmosphere, will be influenced from this cause, and have communicated to it, especially when approximating the earth's surface, a tendency to deviate from the direct parallel line with the Equator Northward and Southward, which line, if traced, would form a left hand spiral figure to the North Pole, — and a right hand spiral to the South; conciding with the known revolutions of these storms on either side of the Equator.

The above explanation may exhibit something of the principle which gives to the Cyclones their respective rotatory motions, but their impetus and subsequent direction, may depend upon some inherent energy possessed by the matter constituting the essential element of the whirlwind.

The vorticular motions imparted to water by moving a body through it in a definite course, supplies a curious illustration of the two opposite rotations in the two hemispheres.

The experiment may be performed at the breakfast table, with a cup of tea, made with curdy milk — and a tea-spoon.

Two eddies thus formed, *revolve side by side in opposite directions,* and progress on either side of the line of motion, with a tendeney

(when a convex body is used, such as a phial,) to be deflected into curves, to left and right.

When the concave surface of the spoon is used, or a flat surface, the eddies revolve nearly side by side along the line of motion. These eddies originate behind the moving body.

We have here three things: — a *fluid; motion* imparted to it in a certain direction; and a *resisting medium;* — the result being two vortices revolving in opposite directions in the fluid; a motion seemingly of the very character of that which influences the revolutions of the Cyclones in the two hemispheres. Corresponding to these, we have — the Atmosphere, in which float the electro-magnetic beams or spirals of which the whirlwind is composed: — secondly — the centrifugal action of the earth's rotation from West to East, — greatest at the Equator, and uniform only on that line: — and, thirdly, the earth's translation, or the impetus with which it is carried forward in space, — reacting and producing the effect of a resisting medium: — the very conditions requisite, perhaps, for giving these peculiar motions to the air at a certain height, and communicating the same to the matter composing the Whirlwind, as it descends to the earth: — and once imparted, the rotatory movements will continue till friction or other counteracting effects cause the cessation.

Whirlwinds may be the means by which accumulated electricity in the Atmosphere is insensibly discharged; they are doubtless powerful means by which evaporation is effected all over the earth, and rain produced and we may imagine, that the Electro-magnetic spirals having discharged their electricity and water, may be again lifted up to the higher regions of the Atmosphere.

The marked fall of the Barometer as the vortex of the storm is approached, may possibly be accounted for by the upward whirling motion imparted to the air by the action of the Electrical spirals, which thereabouts are presumed to be highly concentrated; and the *modus operandi* may be thus explained.

The electrical spiral rotating and working like a screw from above, downwards, sets in motion, by its centrifugal action, a stratum of air immediately surrounding it; outside this again, another circle of winds will be found blowing *centripetally;* — and the two meeting, will, by their mutual action and reaction, continuous throughout, form an ascending current of air working a reversed spiral upwards, the two

motions being well represented by two coils of wire wound in opposite directions, laid one over the other. Plate 14.

This peculiar upward spiral motion, is probably the cause of the ascent of dust in the Whirlwinds passing over a dry sandy soil; and of water in the Waterspout. The enormous height to which the dust ascends, may satisfactorily account for the occasional fall of dust, containing microscopic animalculae and vegetable organisms.

The dust has doubtless been transported from its original bed by Whirlwinds sweeping over land once under water, now dry; carrying up into the higher regions, the lighter portion of the soil containing these miscroscopic remains.

This seems to offer a simple solution of the enigma; but a more curious question is, what becomes of the enormous amount of dust, which, over a broad band of the Earth's surface, far beyond the limits of the Ecliptic, is continually being whirled up into the atmosphere by Whirlwinds: — where does it go to; and what becomes of it?

Regarding the precise nature of the spiral columns, it is impossible at present to say what it is; perhaps the columns represent some modification of matter hitherto unnoticed; or they may be identical with the electro-magnetic-cylindrical beams, supposed by the late Dr. Dalton to compose the *Aurora*.

As they are transparent, their existence can only be inferred by the effect produced on matter over which they pass, as in the case of the Waterspout and Dust Whirlwind, which are familiar examples of their effects when moving over water, or a dry sandy soil: but during a storm, when the whole atmosphere may be filled with dust, or aqueous vapour, no marked indication of their presence is perceptible.

On such occasions, however, the peculiar motions of a vane, oscillating as it constantly does, 4 to 8 points during the gusts, marks plainly the action of the spiral body in passing.

This motion of a vane during a storm, may be accounted for, by supposing that the whirling body in transit, strikes the vane in opposite directions almost at the same moment — the oscillating movement being kept up for a time by conflicting currents of wind following the whirling body, caused by its action upon the air through which it has passed.

The same motion invariably attends the passage of a whirlwind column over a vane, or close to it — hence, in a storm, when we

observe the oscillation of a vane, we recognise the cause, though we may not be able to discern any distinct appearance of a whirlwind column.

The combined forces of the storm, progressive and rotatory, must produce in the immediate vicinity of the vortex, a powerful incurving motion in the winds, as described by Colonel Sir W. Reid and Mr. Piddington; and ships caught in it, may be impelled round and round in the body of the storm, as was the case with the "*Charles Heddle*" in the Mauritius hurricane of 1845. Plate 20.

Such considerations enable us to understand in some degree the cause of the danger incurred the nearer we approach the centre of Action —; and why the incurving winds and powerful spiral vortices, so marked thereabouts, render the condition of a ship so situated at sea, perilous in extreme — especially if once involved in the fatal calm centre. We may also assign a cause for the horribly confused pyramidical masses of raging waters driven by the fierce impetuosity of opposing winds, one against the other, shooting up into the sky — and how a Whirlwind passing over a country, may prove a desolating hurricane, sweeping it literally with the besom of destruction.

We cannot even conjecture, to what height the spiral columns extend into the sky; we must not estimate their height by the storm cloud, which is confined to a few thousand feet above the surface. Most probably, they pierce the heavens to a very great height, and when a storm rages, influence all the overlying strata, which are constantly observed through a break in the clouds over head, to be in commotion, affected with varied and opposite (zigzag) movements, evidently influenced by the self same cause that sets the storm in motion below. Lahore, August 1851.

RECAPITULATION OF THE PRINCIPAL **FACTS** UPON WHICH THE THEORY OF WINDS NOW PROPOSED, IS BASED.

NOTES OF 1851.

1. — My experience of the smaller dust Whirlwinds, leads me to believe, that they travel uninfluenced by the direction of the prevailing surface wind, which may have been blowing prior to their appearance, and indeed, they often come up from an opposite point of the compass.

If they are, as I am certain is the case, *themselves the exciting cause of wind,* the reason of this is obvious.

2. — They rarely deviate materially from their original course, though they commonly progress more or less in a wavy line now on one side of the path, and now on the other.

3. — They turn indifferently from left to right, or from right to left, and their rotatory motion sometimes seems suddenly reversed; though that may be only an optical illusion.

4. — During strong winds, and in stormy weather, the spiral columns, though in full force, are not easily recognisable even when passing over a light dry soil, and would be entirely unnoticed by most persons.

5. — When numerous, they are frequently observed advancing in a line, and after passing the observer, an interval of some minutes may elapse, before another set is seen in the distance, and so they continue, one set succeeding another, giving rise to squalls and lulls, or rising and falling of the wind.

6. — Their rate of progression is liable to great variety; being sometimes retarded, and then again accelerated without apparent cause; but in a brisk wind, their progress is more uniform.

7. — They appear with great regularity between, though sometimes a little before and after, the hours of 10 A. M. and 4 P. M. increasing in frequency with the heat of the day, and declining as the sun approaches the Western Horizon; ceasing altogether before sun-set, when the wind drops. From the fact of their appearing in greatest numbers during the hottest hours of the day, it would seem that the

solar influence may be considered at least a subordinate cause in bringing them into action.

8. — The winds caused by the passage of whirlwinds, or electro-magnetic spirals through the air, are characterized by gusts, or flaws, succeeded by lulls, and are of a totally different description from the winds caused by variations in temperature.

9. — The dust Whirlwinds are usually composed of many single spirals joined together, which may separate, and re-unite again with augmented power.

10. — They preserve a distinct columnar form to the height of three thousand feet and upwards, and terminate in a cloud of dust, which still possesses a gyratory motion, ascending higher and higher.

11. — A dust column or pillar of considerable height is, sometimes, observed broken in its ascent, into two or three lengthened irregular patches of dust, with perfectly clear intervening spaces; the dust all the while ascending with rapidity into the higher regions, as if the electrically charged pillar, were endued at times with an increased centrifugal force. It might be supposed that this alternate increase and diminution of the volume of dust whirled up into the air, was owing to different kinds of soil over which the whirlwind then rotated; but attentive observation showed that it took place indifferently, whether the body continued to whirl over the same spot, or moved onwards: and it seemed to be occasioned by the alternate increase and diminution of the rotative energy of the *interior* column; — that in proportion to the activity of its spiral descent, so was there a corresponding energy of *ascent* established between the earth and the heavens.

12. — Their rate of upward ascent is subject to variation, as well as that of their onward motion.

13. — A lofty dust column, moving slowly, may sometimes be seen to assume, in the course of a few seconds, a wavy and slightly contorted appearance in its vertical section, while still preserving its exact cylindrical form; the change being effected simultaneously, throughout its entire height.

14. — Kites, which are numerous in this part of the country, often follow dust Whirlwinds for some distance, soaring about and around them, diving at each other as if in sport, keeping pace with them, seemingly, with no other purpose than that of enjoyment.

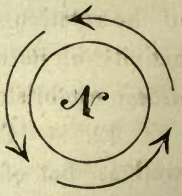
15. — Evaporation is much increased when the Whirlwinds are frequent and the wind brisk.

16. — In damp weather, the passage of the electrical spirals over an insulated wire, fails to affect the gold-leaf electrometer; and during this humid state of the atmosphere, the electrometer can only be exited with difficulty, and loses that power, the moment the excitement is removed.

17. — Once, when observing the peculiar motions of a well defined slender dust pillar, rotating briskly, but at the same time remaining almost stationary on the one spot, and while looking upwards at the body of the column with the view of understanding the particular course the dust was taking in its ascent, the pillar was suddenly withdrawn, or lifted upwards, and carried out of sight: — and this occured so suddenly, as to give the impression of its having been divided asunder; particularly as the outer stratum of dust remained for a few moments suspended in the air: — but on again directing the eye to the earth, the absence of the rotatory motion and of the cone of dust, at once explained the real state of the case.

18. — In March last, during unsettled stormy weather, my attention, was directed to a large mass of dust Whirlwinds to the Northward, moving from west to eastward: all at once, their course was entirely changed; and they were seen coming back from N. E. to S. W. This strange and sudden shift, may perhaps be explained, by supposing that the mass of Spirals moving in a zigzag course, recurved at that particular time.

19. I once followed, for more than a mile, a dust Whirlwind of about 4, or 5 feet in diameter, travelling at the rate of 7, or 8, miles an hour, and rotating from right to left.



After a time, its progress was retarded, so as to enable me to penetrate to the centre and to walk slowly with it for a short distance: The centre was perfectly calm, while round about, the winds were blowing in every direction: Though surrounded by dust, I was enabled, by keeping my eye fixed upon the whirling line of dust at my feet, as it continually swept past me on the right, (the side of progression) to preserve my position in the central calm space, for some little time, without being inconvenienced by the dust. On the left hand side of the whirl, the dust was not so well defined, but cloudy and confused.

There was in this case, as in all others of a similar kind, a train of dust closely following, occasioned by the action of the Whirlwind upon the air.

20. — Westerly winds, or rather West South West, seem almost invariably to prevail at Lahore, at the height of 3 or 4 miles above the earth's surface, in the region of the Cirro-Stratus or Cirrous.

When clouds prevail with fine weather, they usually clear off about sun-set with the greatest regularity, at which time they are observed progressing Eastward, from the West, with considerable velocity; which would lead to the supposition that at this height, the prevailing currents, when not disturbed, are always in that direction. — The same thing is often observed at sun rise.

21. — The peculiar manner in which the winds blow after a Whirlwind of small diameter and swift progressive motion, is somewhat remarkable, and deserves attention.

Plant yourself in the direct line of an advancing Whirlwind, and allow it to blow over you. After it has passed, there will generally be perceived more or less of a lull, or the winds blowing in the direction of the track will be found light and unsteady.

This may continue for a minute, more or less, by which time the Whirlwind may have travelled onwards 150 or 200 yards.

All at once, the breeze freshens, and blows steadily and with increased force for a lengthened period; after which, it may drop and then again revive for a shorter period, becoming again unsteady, and by degrees fainter, and then ceasing altogether. Though I have frequently remarked the fact, I am not prepared to account for it, further than to remark, that the light unsteady winds, at first, may be occasioned by eddies caused by the rotatory action of the Whirlwind on the Air more immediately adjacent: while, the stronger winds, may be the oblique currents on either side of the track, meeting on the line, and combining to produce increased power and velocity. More exact observations, however, are requisite to enable us to determine the real cause of this striking phenomenon.

22. — When Whirlwinds are moving about, white patches of Cirro-cumuli are frequently seen on the clear blue sky, exactly resembling flakes of teaseled cotton, having rotatory motions throughout, forming, and then rapidly dissolving or ascending with whirling motions

into the higher regions, becoming more and more faint, as they recede from the sight.

23. — *Peculiar effects of Wind.* — During a brisk wind, blowing over a dry sandy soil free of vegetation, trains of dust are observed constantly passing in the direction of the wind, and preserving more or less a wavy course.

These trains of dust are remarkable for always being subdivided into narrow streamlets of dust 2 or 3 inches, or more, apart, running parallel, and following the same kind of wavy course, as if affected by some general law.

An explanation of this may be attempted, by supposing that the stream of air, following the electrical spiral, and excited by it, becomes affected, throughout, by minute eddies, which being carried onwards with the general current at a rapid pace, lose their circular form and become converted into wavy lines, rendered visible by the dust they carry along with them.

This wavy course, assumed by the currents of air, explains, in a very satisfactory manner, the cause of the oscillation of a vane during stormy weather.

24. — When the whirlwind sweep is rather considerable, that is several yards in diameter, the surface of the ground over which it has just passed, is marked with many points of eddies, shooting here and there in different directions, in a most complicated manner — the streams of dust becoming eventually more regular as the after currents prevail and influence them.

25. — When the whirlwind column meets an obstruction, such as a wall or building, it goes right straight over it, without being deflected: while the after currents, and dust eddies that follow, are deflected and reflected by any object opposing the passage, just as a stream of water might be supposed to do. For instance, an after current, charged with dust, when meeting a wall with an open gate way, was deflected along the wall; but on meeting the open gate, it passed through it, as water would have done.

26. — When the gusts sweep over still water, or water with a slight ripple on the surface, a very peculiar appearance is produced as if a body of smoke, or a dark shadow, passed rapidly over, progressing in a wavy form, precisely similar to what is observed of the dust on land.

This curious appearance seems to be occasioned by a sudden impulse given to the crests of small waves by the passage of the minute currents of wind, which producing at the same instant a sulcated or furrowed surface of the water in advance of the wave crests, cause the surface to be thrown momentarily into strong light and shade, and give it the peculiar appearance described.

The following account, by Captain Gastrell, of the effects produced upon an Electro-magnetic battery in action during the passage of a Dust-Storm, will be read with interest.

"I have the pleasure to send you a Memorandum of the phœnomenon I mentioned to you, as observed by me, at Cawnpore, with the Electro-magnetic machine, during the passage of a Dust-Storm.

In the hot weather of 1847, I was experimenting one day at about 11 A. M. with an Electro-magnetic Machine. It was of small size. — The wire coil about 300 yards in length and fine. The battery I was using to impel the magnet in the break cup, was one of 12 or 16 pairs of zinc and copper plates, each plate about 4 inches square, and was charged with diluted sulphuric acid and water. Shortly after the Battery and Magnet were in action, and sparks passing freely, a dust storm came up from the West, passing directly over the house I was in, towards the N. E. or E. N. E.

On its approach, I observed the action of the Magnet decrease gradually until, in the dead lull or calm that usually precedes such storms, it ceased revolving.

The action of the Battery during the same period, increased in intensity, and apparently in proportion to the decreased revolutions of the Magnet.

It was at its Maximum of intensity, about the time the centre of the storm was passing. Supposing the stoppage of the Magnet might be owing to too much energy in the Battery, I disconnected the coil, and placed it in connection with a single cell Battery with platina plates.

This I charged with a solution of sulphuric acid and water, decreasing the strength of the solution with more water, from

time to time, but with no effect on the Magnet. I then emptied the cell, and charged it with a solution of common salt and water with the same unsuccess. I then removed the single cell Battery, and reconnected the Coil with the 12 plate Battery, and left it.

No sooner had the storm of dust passed, and light rain began to fall, than the action of the Battery became quieter, until the hissing sound ceased, and the Magnet again began to revolve; sparks of course passed, and shortly, the Magnet revolved as quickly as it did previous to the storm.

I mentioned the circumstance to my Cousin, Colonel Wilcox, astronomer at Lucknow, and asked him, if he had ever seen a similar circumstance mentioned; or, if he had ever observed his Magnets in the Magnetic observatory at Lucknow, in any wav affected, during the passage of a dust storm. He replied he had not, and could not account for it in any way. Quere? Is there any point in the track of the dust storms, (which are undoubtedly of the Nature of Cyclones,) in which, if a Magnet happened to be, it would lose its polarity for the time, ceasing to be a Magnet?

If so, the cause would be clear; this did not strike me at the time, or I might have easily tested it.

I recollect another Phœnomenon observed in one of these storms. It occurred during the march of my Regiment up country to join the Army of the Punjab. We had left our ground long before day light, and were caught in a dust storm, followed by very heavy rain and vivid lightning. When the rain fell, the muzzle of the men's muskets and the peaks of the Officers' caps, were seen tipped with that well known Electrical appearance, called St. Elmo's-light, and this appearance continued for some minutes, a quarter of an hour perhaps. I am not quite sure now, whether I ought not to sav, the tips of the Bayonets, and not the muzzles, as we were marching with treasure, and I think Bayonets fixed."

In Noad's Lectures on Electricity, page 337, is the following; —

"It is an admitted fact, that the *Aurora borealis* is a powerful source of magnetism, and that the *South* pole of the needle has a distinct connexion with it. Dr. Dalton, in a work

published in 1793, has advanced several ingenious hypothetical views, respecting the cause of the Aurora, and its magnetic influence. He says: — "the region of the Aurora is one hundred and fifty miles above the earth's surface. Immediately above the earth's surface is the region of the clouds, then the region of the meteors, called falling stars and fire-balls, and beyond this region is that of the Aurora. — Again: —

"We are under the necessity of considering the *beams* of the *Aurora borealis* of a *ferruginous* nature, because nothing else is known to be magnetic; and consequently that there exists in the higher region of the Atmosphere, an electric fluid partaking of the properties of *iron*, or rather of *Magnetic steel;* and that this fluid, doubtless from its magnetic property, assumes the form of cylindrical beams. With regard to the exciting cause of the Aurora, I believe it will be found in change of temperature. Nothing is known to affect the magnetism of steel: heat weakens and destroys it; electricity does more; it sometimes changes the pole of one denomination to that of another, or inverts the magnetism. Hence we are obliged to have resource to one of these two agents, in accounting for the mutations above mentioned. As for heat, we should find it difficult, I believe, to assign a reason for such sudden and irregular productions of it in the higher regions of the atmosphere, without introducing electricity as an agent in these productions; but rather than make such a supposition, it would be more philosophical to suppose electricity to produce the effect on magnetic matter **immediately.** The beams of the *Aurora* being magnetic will have their magnetism weakened, destroyed, or inverted, *pro tempore*, by the several shocks they receive during the aurora." In another place he says: — "I conceive that a beam may have its magnetism inverted, and exist so for a time, &c." Again:

— "as the beams are swimming in a fluid of equal density with themselves, they are in the same predicament as a magnetic bar or needle swimming in a fluid of the same specific gravity with itself; but this last will only rest in *equilibrio*, when in the direction of the *dipping needle*, owing to what is called the *earth's magnetism;* and as the former also rests in that po-

sition only, the effects being similar, we must, by the rules of philosophising, ascribe them to the same cause. Hence then it follows, **that the Aurora Borealis is a Magnetic Phenomenon, and its Beams are governed by the earth's Magnetism.** I am aware that an objection may be started to this; if the beams be swimming in a fluid of equal density, it will be said they ought to be drawn down by the action of the earth's magnetism. Upon this I may observe, that it is not my business to shew why this is not the case, because I propose the magnetism of the beams as a thing demonstrable, and not as a hypothesis. We are not to deny the cause of gravity, because we cannot shew how the effect is produced. May not the difficulty be removed by supposing the beams of *less* density than the surrounding fluid?"

A copy of the chart of the *Charles Heddle* in the Mauritius Hurricane of 1845, as delineated by Mr. Piddington, in his 13th Memoir, and published in the Journal of the Asiatic Society of Bengal, Vol. XIV. P. 703, is here introduced, as it seems to afford a remarkable confirmation of the theory of the motions of Cyclones here proposed. At page 156 of "Piddington's Sailor's Horn Book," is the following brief account of the *Charles Heddle's* Manœuvres.

"In the Southern Indian Ocean, the Brig, *Charles Heddle,* to which I have before alluded (P. P. 40 and 89) between the 22nd and 27th of February, scudded *round and round* on the track of a Cyclone for five successive days! When her log was carefully worked up, it was found that by it alone her course and distance was *North* 42·, East, 111 miles, while by good latitudes and Chronometer sights, before and after the Cyclone, she had really made good in these few days a course and distance by observation of *South* 55· West, 366 miles; giving her thus, a current (the Storm wave,) of South 52· West, 476 miles, or in round numbers (which would require 480 miles,) four miles per hour for the 120 hours, or five days.

The average distance from the centre at which she scudded round it, is about 42½ miles; the greatest being 62 miles, and

the least 25 miles. There is no doubt of the carefulness and authenticity of this vessel's log, which was procured for me by the Master attendant at the Mauritius, Capt. Royer, and of her position being nearly correct, for she had just left the Mauritius and returned to it after the Cyclone; it is thus clearly an unquestionable instance of the Storm Wave.

ON THE FORMATION OF HAIL.

A violent hail-storm from the N. N. E., with vivid lightning, occurred at Meean Meer, near Lahore, on the evening of the 24th of March last, three quarters of an hour after sunset, which lasted about 20 minutes: — and early the following morning, before sun rise, another hail-storm occurred, accompanied with thunder and lightning, and violent squalls from the North-West.

Showers of hail, as I afterwards learned, prevailed in other parts of the Punjab about the same time.

The weather, previous to this, had been unsettled and stormy for many days, and the night before, heavy rain fell.

On the afternoon of that day, the weather cleared, but heavy masses of Cumulo-stratus collected over the sky, particularly to Northward, in which direction, and to West, a dense voluminous cloud of this description occupied a large portion of the heavens up to the zenith, and continued stationary a long time, its margins lighted up by the sun, all the while in slow vermicular motion, like huge curling wreaths of snow. At sun set and after, the cloud occupied nearly the same position, but more to Westward; and tortuous thready lightning played through it, and over it, incessantly, and distant thunder rolled. The sky at this time presented a very stormy appearance to Northward; all round from E. to W. and rainy looking clouds approached rapidly from the N. N. E., and an occasional drop of rain, from the clouds above, seemed to threaten an instant deluge. Some time after, the hail fell: at first slow, then quickly followed a rattling shower of hail-stones the size of musket bullets, and 10 minutes after a tremendous volley of them, nearly as large as walnuts, which continued many minutes, and terminated in rain and showers of small hail. The Barometer was not all affected during this shower of hail.

The lightning of hail-storms, which in this case, continued almost incessantly, may be caused by the enormous evolution of caloric emitted at the instant of congelation of the rain drops. It is therefore an *effect;*

and though practically simultaneous with the consolidation of the hail, it might, were it possible to measure such a fraction of time, be said to occur *after* the consolidation; which may likewise be true of the condensation of aqueous vapour into rain, as well as of the rain drops into hail.

This view of the case is strengthened by the phœnomena attending the sudden freezing of water and rapid crystallization: as Mrs. Somerville says, "Prodigious quantities of heat are constantly becoming latent, or are disengaged by the changes of condition to which substances are liable in passing from the solid to the liquid, and from the liquid to the gaseous form, or the contrary," and, "water at the temperature of 32°, must part with 140°, of caloric, before it freezes," and Sir R. Phillips, — "M. Pontus, of Cahors, in freezing a phial of water, with a small tube, joined to it by ether, under an exhausted receiver, found that at the moment of congelation, a spark of light proceeded from the small tube." And: — "when a capillary tube of water is fitted into a phial of water, and both are frozen, a flash of light proceeds from the capillary tube. When crystals are formed, flashes in like manner proceed from them. When water is frozen into hail in the atmosphere, great electrical phœnomena take place, and the hail is usually occompanied by flashes of lightning." And Dr. Thompson's experiments, detailed by Mr. Edwin Sidney, of Norwich, "if a vessel of water be carefully covered, kept free from agitation, and exposed to a temperature of 22°, it will gradually fall to that temperature, still remaining in the liquid state; but if a tremulous motion be communicated to it, or a particle of ice or other solid substance dropped into it, its temperature will suddenly rise to 32°, and a portion of it will be converted into ice. The cause of this singular effect is easily explained; a portion of the liquid which is suddenly solidified, gives out a quantity of heat, which is in part communicated to the water which still remains liquid, and raised it from 22° to 32°, and the remainder of it becomes sensible, instead of being latent, in the ice itself, and likewise raises its temperature to 32°."

The smaller hail was globular, about the size of a musket bullet, and nearly smooth externally, and contained a snow-white nucleus.

The larger hail-stones were mostly of an oval form, sometimes flattened; the surface of all being rough, like a mulberry calculus, or covered with angular projections of ice, as if stuck over with crystals.

They also contained a white nucleus, which seemed to be of precisely the same size in all. Small amorphous masses of ice also fell, but they were rare, and the only one I saw, contained no nucleus, but appeared homogeneous. — Fig. 5, Plate 12 and Figs. 1, 2, 3, 7.

On splitting the larger hail stones in their longer diameters, a radiated and cellular structure was visible, surrounding a white nucleus. Figs. 4, 6.

The nucleus itself was composed of two parts; a central spot of pellucid ice, *a*, one-third of its diameter, enveloped in a porous snow-white layer *b*, which peculiar appearance was due to the presence of minute air bubbles.

Next in order, were one or more thin concentric layers of ice free from air bubbles, delicately marked like the lines in agate, *c*, beyond which, the radiated and cellular structure became most apparent, *d*.

The rings surrounding the nucleus, and the radiated and cellular structure, were all marked by the interposition of microscopic air bubbles, which, by the aid of a lens, were observed to be arranged in transverse lines with some regularity. — Fig. 10, *g*.

The division into cells was best seen when the hail-stones began to melt, and the surface became smooth. — Fig. 7, 11.

Air bubbles, of a larger size, were also found interspersed, here and there, through the body of the hail-stone, *e*.

In one hail-stone I examined, a few minute air bubbles were discovered in the centre of the pellucid spot of the nucleus, Fig. 8 — which might be the included air of the few central rain drops, as in Fig. 13.

A consideration of the peculiar structure of hail-stones, as now described, the uniformity of their appearance, but especially their cristalline and radiated structure, leads me to suppose, that the formation is effected by the sudden agglomeration of the rain drops formed in the higher and colder regions of the atmosphere, and that it is instantaneous. The rain meeting in its descent a colder stratum of air in motion, parts with more of its caloric, and instant congelation ensues, with the simultaneous evolution of light.

The hail-stone, when thus uniform, undergoes, as I suppose, no increase in size during its descent, by the attraction of frozen particles, but on the contrary, its form and bulk seems to be determined by the number of the rain drops at the instant of its formation.

We may imagine that a stratum of rain is cooled down in its descent below freezing, — when on a sudden, the whole sheet becomes simutaneously affected by the laws of crystallization or the freezing of water, and points of convergence forming, the rain-drops in the act of congelation, rush as to a centre and arrange themselves.

A few drops of rain, at the point of convergence, coalesce and constitute a nucleus, round which all the others pack themselves in exact order according to their distance from the centre of that particular point, — giving rise to concentric layers, and to the radiated and cellular structure apparent throughout. — Fig. 12 illustrates the idea.

This molecular arrangement is so rapid, that the film of air surrounding each rain drop, is enclosed and becomes fixed, marking the partitions: the drops originally spherical, assuming sided, or geometrical figures by the compression they are subjected to at the moment of congelation; and the porosity of the ice about the nucleus, may be accounted for on the same principle, by the simultaneous convergence of the drops of rain, causing a body of air to be driven before them to the centre with great velocity, and there fixed.

Shooting stars, fire balls and meteoric stones *may*, like hail, owe their development to molecular attraction, and be sometimes of telluric or atmospheric origin.

Their constituents are, probably, all derived from the earth's surface, and in the case of the meteoric stones, this would seem indubitably so: silica, iron, and magnesia, being their chief components, besides which, according to Baron Humboldt's Cosmos, they also include nickel, cobalt, maganese, chrome, copper, arsenic, tin, potash, soda, sulphur, phosphorus and carbon, and sometimes perfectly formed crystals of olivine, labradorite and pyroxene, some being almost entirely metallic, while others consist of earthy materials.

Baron Humboldt also remarks, "they exhibit, on the whole, a general unmistakeable resemblance to one another in their external form, in the nature of their crust, and in the chemical composition of their principal constituents; and this resemblance is traceable when and wherever they have been collected, at all periods of time and in all parts of the earth."

These substances are doubtless volatilized in large quantities from volcanoes, and other sources, and may form a stratum of mineral matter in a gaseous state, circulating in the higher regions of the atmosphere,

whence, as from a magazine, portions may, from time to time, be diverted downwards, and then, under certain conditions, electrical or other, become suddenly condensed into a solid, as in the case of hail, and fall to the earth with great velocity: — such condensation being necessarily accompanied with the development of intense heat, which again expanding the elastic vapours contained within some of them, may cause their explosion, and the scattering of the fragments to the earth.

This idea is strengthened by the fact, that some possess a distinct radiated structure; and fragments of others have been observed, "remarkable for a highly regular prismatic figure, suggesting the idea of a portion of a basaltic column, and of its having once formed part of some extensive formation." Vide American Journal of Science &c. — Vol. II, — No. 31.

A remark by Sir R. Phillips, tends also to confirm this view of their origin: — "on October 8th, 1827, a shower of aerolites fell near Belostok, between 9 and 10 in the morning. An extraordinary noise, which proceeded from a large black cloud, and continued for 3 or 6 minutes, resembling a running fire of musketry, was succeeded by a shower of stones of which only 4 were picked up: the largest weighed 4 lbs, the smallest three quarters." And Baron Humboldt again remarks — "Meteoric stones sometimes fall from fire-balls with a force which causes them to sink to a depth of from ten to fifteen feet into the earth," — and, "in other instances, a small and very dark cloud forms suddenly, in a perfectly clear sky, and the stones are hurled from it with a noise resembling repeated discharges of cannon. Such a cloud, moving over a whole district of country, has sometimes covered it with thousands of fragments, very various in size, but similar in quality."

"A phœnomenon of still more rare occurence took place on the 16th September, 1843, when a large ærolite fell at Kleinwenden, not far from Mulhausen, accompanied by a thundering noise, but with a clear sky, in which no cloud was formed. As further evidence of the affinity between fire-balls and shooting stars, it should be noticed that fire-balls, from which meteoric stones have descended, have sometimes been seen, as at Angers, on the 9th June, 1822, of a diameter hardly equal to that" of the small Roman candles in fire works." Again "we have as yet scarcely any knowledge in regard to the physical and

chemical processes which contribute to the formation of these phœnomena."

The American Journal also, — "on the infusoria and other microscopic forms in Dust-showers and Blood-rain, by Dr. C. G. Ehrenberg," remarks, "A simultaneous occurence of Dust-showers, and falls of meteoric stones, has been observed probably *eighteen* instances before the Christian era; during the Christian era, *fourteen* coincidences have been observed, making thirty-two in all."

Shooting Stars and *Aerolites* may therefore be subjected to one rule and, like hail, owe their formation to the sudden condensation of matter in a state of minute division.

The shooting stars appear to be of a more volatile nature than the Aerolites, and are unattended with the violent action, that usually characterizes those of a mineral origin.

Their height in the atmosphere varies much, some having been seen below clouds, while others are imagined to have been projected from a distance beyond the supposed limits of our atmosphere.

The Shooting Stars, sometimes, leave a phosphorescent train of light along their path, visible for more than a minute, the luminous track occupying apparently the same spot, and becoming fainter and fainter, and at times slightly wavy, as is affected by the atmospheric currents, not far remote from the earth's surface.

On the 15th of August, 1851, at 10 P. M., while in company with Lieut. C., we noticed a shooting star of some brilliancy sweep across the Northern Hemisphere, from East to West, *beneath* the sheet of Ciro-Cumuli which then covered the entire heavens, and was probably from two to four miles abovo the earth's surface. The star was first noticed when 40° or 50° above E. Horizon. It then crossed the sky below the zenith, and seemed to enter the cloud for an instant, — then shot out again, and vanished 10° or 15°, above the horizon to West, taking more than three seconds to run its course. The first part of its flight was much the longest, and it left a luminous train visible for a few seconds.

I have, on several other occasions, witnessed shooting stars below clouds, but none so distinct as this.

Dust-rain, which may be of more frequent occurrence than the fall of *Aerolites*, probably owes its origin, as before suggested, to the dust raised by Whirlwinds, and kept suspended in the atmosphere by

the upper currents, whence it may again descend as dust-rain, either alone, or, as sometimes happens, with a fall of meteoric stones.

The chief objection to the theory of the atmospheric origin of Aerolites appears to be, their planetary velocity, and the direction they take, being for the most part diametrically opposite to the motion of the earth in its orbit, the same objection that is urged against the idea of their coming from the Moon: on this point, Baron Humboldt says in his Cosmos: —

„The planetary velocity, and the retograde, or opposite directions of the paths of the Meteors to that of the earth, the principal grounds which are considered subversive of that hypothesis, which attributes the origin of Aerolites to the supposed active volcanoes of the moon," and again in note 69, Vol. I of his work, a remark appears as follows; — "on the improbability that Aerolites formed from gas, holding in solution metallic substances, which, according to one Fusinieri, exist in the Upper strata of the atmosphere, and which suddenly aggregate from a state of extreme dispersion, &c."

Some Aerolites, thus formed at a great height in the atmosphere, may at the instant of their condensation, be attended with such violent action in opposite directions, as to annihilate for the time, all motion and the Aerolite, thus suspended as it were in mid-air is met by the earth, advancing in its course, and dashed to the ground with planetary velocity; *appearing* to fall, while in reality, the body itself is passive; just as a traveller, speeding at the rate of 60 miles an hour, sees the objects at rest close along side as if they were in rapid motion, while he himself is not conscious of moving.

ECCENTRIC MOVEMENT OF A STAR.

Three officers of the Bengal Artillery relate as follows; — "One evening, during the last week in April, an hour and half after sunset, the atmosphere being perfectly clear and without clouds, and no moon shining, a little haze only, low in the horizon, three of us, Lieuts. Machell, Turnbull and myself, saw a star in the west move and undergo sundry eccentric motions.

When first noticed, it was at an elevation of about 12° above the horizon, and its direction from us was about W. 10° S.

We imagined it must be merely an optical illusion, but each of us then looked at it from a fixed position, and brought it on a line with some fixed object.

M. reclined his head against a wall, and brought it in a line with a string held vertically, as in laying a mortar. I also adopted a plan, and brought the Star in a line with the two posts of my bed, and we each remarked that the Star moved a good deal to the left of us, that is, in a Southerly direction, though not in a direct line, South.

It sometimes dropped down some distance and went off in a zig-zag direction, then rose again, and at times remained stationary. It also varied much in brilliancy and in colour, sometimes becoming quite bright, at other times scarcely perceptible. When it approached the horizon, we generally lost sight of it altogether, which may possibly be accounted for by its getting obscured in the haze. The Star once or twice moved to the right, but during the half hour we continued to observe it, it had moved considerably to the left of our position, or to the South, over a space perhaps of 8° or more. It described no regular motion, and went off by fits and starts, and varied from its original position in the heavens considerably, as I tested by forming a triangle with it and two other fixed stars.

Its velocity too was different at different times.

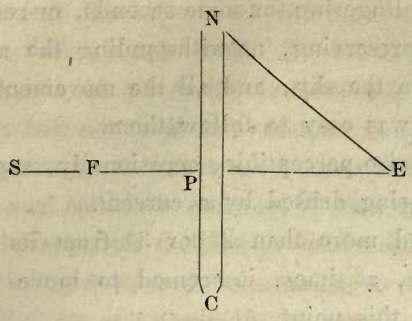
My decided opinion is that it was not a meteor, but one of the fixed stars, though I confess I have not been able to identify it with any one of them since that night."

Meean Meer, Lahore, 3rd July, 1852.

"I have not been able to refer to my journal for the date of the evening when I saw the star making its eccentric motions, of which you wish me to give you an account. As well as I can remember, it must have been at the end of April or beginning of May last, and I suppose between about 7½ and 8½ in the evening, that I remarked the star in question. It first attracted my observation by falling rather rapidly for some little distance, say a distance of 1 or 2 degrees: I say rather rapidly, for so it was in comparison to its subsequent movements; but it was not so fast at the descent of a "shooting star," but it was much like one in appearance when it *commences* its descent; or if my observations be correct "falling stars" increase their velocity very considerably as they progress in their fall.

After looking at the star, for a second or so, I pointed it out to one or two friends, who were sitting with me in front of my house, and we observed its movements together. I think, after its first fall, it again fell, but not so rapidly, nor so far. It then, I think, ascended slowly and steadily, but still very perceptily. It ascended to near its original position, and then again I think descended to the right, after which it seemed to travel about without any apparent law, to right and left, and up and down, and also with variable velocity and with different degrees of brilliancy: at times it was rather brilliant, much more so than most of the stars then visible, and also, I think, it appeared larger. Its color was reddish; at times it became less brilliant, and at one time scarcely perceptible, and once (or twice) only, I think, before we finally lost sight of it, it became imperceptible. If there was any law in its velocity, it was, that its descents were more rapid than its ascents, or than its motions to the side, but sometimes its descents would be as slow and steady as its ascents; sometimes its movements were so slow and steady that it was difficult to perceive which way it was going.

Supposing the part marked N., to be the spot in the heavens, where I first saw it, its movements were thus: — N., where it first started and fell to P., then again to C, then it rose to N, then travelled to E, then to F, after which, I forget its course,



but I remember it returned once or twice to near its original position N, and finally disappeared, towards the point S: at least, finally to our view, for we then ceased to watch it, after watching a short time for its re-appearance. We waited for its re-appearance a longer time than we did when it disappeared on the former occasion, though we did not, I suppose, wait above a minute or two. The whole time we were looking at it was not above a ¼ of an hour, more or less, but I cannot be certain of that; the position of the star by the compass was about a little more West than S. W., may be, 5° W. of S. W. Its height in the heavens, when at the highest, was 20°, or so."

(Signed,) S . . . ., *Lieutenant,*

5*th July* 1852. *Artillery.*

ECCENTRIC MOVEMENT OF STARS.

OPTICAL PHŒNOMENON.

At Meean Meer, near Lahore, on the night of the 10th September, 1852, about half-past nine, the atmosphere being perfectly clear, and no moon shining, I observed the planet Saturn, then about 12° or 15° above the horizon to the E., in motion, and watched it, for near two hours, undergoing sundry eccentric movements.

It was seen to move up and down, to the right and left, obliquely, in a horizontal line, sometimes with slow wavy motions, at other times

with a circling movement, now lingering for some seconds, or remaining stationary for a longer time; preserving, notwithstanding the apparent changes, its general position in the sky, and all the movements being conducted so leisurely, that it was easy to follow them.

A fluctuating motion was also perceptible, occasionally, suggesting the idea of a luminous body being drifted by a current.

The planet seldom shifted more than 2° or 3° from its general position in the ecliptic, though, at times, it seemed to move further; but I was unable to determine this point.

No marked change was perceptible in its appearance during the movements; but it was noticed that the movements were limited in proportion as the star ascended in the sky, and by the time I ceased to observe, though still distinct, they were much less remarkable than at first.

Some minutes after my attention was first attracted to the phœnomenon, I was joined by Lieutenant Carnegie, and we both sat watching the star for nearly an hour. I next turned my eye to a fixed star, shining with considerable brilliancy, above 12° above the horizon to the N. E., and discovered that it was affected much in the same manner as the planet; and that it underwent increase and diminution in size, and in the resplendency of its prismatic colours as it rose and sunk.

Having satisfied myself here, I turned to the opposite quarter of the sky, and found that two or three of the brightest fixed stars thereabouts seemed to move. I afterwards remarked a fixed star with a reddish tinge which rose in the East some time after Saturn, when it had attained to the height of 10° or 12° above the horizon, undergo precisely the same kind of motions.

The atmosphere was probably more humid than usual, for the day had been cloudy, and between two and three in the afternoon a storm of wind and rain from the S. E. occurred; but the clouds dissolved away soon after sun-set, and the sky became clear.

Small shooting stars swept the heavens now and then — distant lightning in the north from a low bank of clouds near the horizon.

The air was almost still — a light breeze from the eastward passed occasionally by.

On the 13th a similar appearance was observed. Shortly before 9 P. M. the sky being clear, a fixed star, 12° or 15° above the horizon to the west, was observed by myself and Lieutenant Carnegie to move

and undergo the same kind of irregular movements as before described: and the following morning, at dawn, I observed the planet Venus, then above 33° above the horizon to the east, to be affected in like manner; and now that my attention is directed to the subject, I perceive the phœnomenon, with more or less distinctness, on every clear night; and it only astonishes me that it was never remarked before.

The apparent motions probably depend much upon the degree of moisture in the atmosphere, and upon the height of the star above the horizon — for stars seen in the zenith do not appear to move at all, while those near the horizon do move considerably. I conclude, therefore, that the apparent motion of the star is due to a humid state of the atmosphere, or to rarefaction like the mirage, — a purely local cause; and that the laws of refraction will afford a satisfactory and complete explanation of the nature of this singular phœnomenon.

Meean Meer, 29th Sept, 1852.

The following account is quoted from the Year-Book of Facts, 1852, to shew the interest attached by scientific men to the above subject: —

Eccentric Movement of the Fixed Stars.

"At a meeting of the Berlin Academy of Sciences, held on May 31 last, the venerable Alexander Humboldt made an interesting communication upon some observations of singular Movements of the Fixed Stars. It seems that at Trieste, Jan. 17, 1851, between 7 and 8 o'clock, P. M. before the rising of the moon, when the star Sirius was not far from the horizon, it was seen to perform a remarkable series of eccentric movements. It rose and sank, moved left and right, and sometimes seemed to move in a curved line. The observers were Mr. Keune, a student in the upper class of the Gymnasium, and Mr. Thugutt, a saddler, both certified to be reliable persons. The family of the latter also beheld the phœnomena. Mr. Keune, with his head leaned immovably against the wall, saw Sirius rise in a right line above the roof of a neighbouring house, and immediately again sink out of sight behind it, and then again appear. Its motions were so considerable that for some time the beholders thought

it was a lantern suspended by a kite. It also varied in brilliancy, growing alternately brighter and fainter, and now and then being for moments quite invisible, though the sky was perfectly clear. As far as it is known, this phœnomena has been remarked but twice before: once in 1799 from the Peak of Teneriffe by Von Humboldt himself; and again nearly fifty years later, by a well-informed and very careful observer, and by Prince Albert of Prussia."

ON THE MOTIONS OF THE SEA IN A STORM.

In attempting to give a general idea of the complicated movements of the waves in a storm, and the exciting causes, we must commence by supposing a dead calm at sea, the surface of the ocean still, and smooth as a looking glass, and not a breath of wind stirring.

The wind rises, and comes at first in light puffs, ruffling the surface of the water into crescent shaped undulations of small size, directed forwards with the wind, and moving at a slow pace, about a mile or two an hour. These undulations, when on a small scale, may be seen to diverge as from a centre, and there being many points of origin, the curves of undulation cross or intersect, counteracting each other's effects at those particular points and causing the waves to assume something of a lozenge shape, which general figure is preserved for a time, while their size is increased, and their velocity accelerated by every succeeding gust of wind.

The influence extends at first only to the surface; but soon as the breeze freshens, the size of the waves is proportionably increased, and their onward motion quickened; till at length, the whole body of water over which the influence of the storm extends for the time, to the depth of several feet, partakes of the violent motion imparted to it by the wind; and now the form, which marked the waves at first, is no longer discernable, but is merged into lengthened undulations, which thus present a more direct surface to the action of the winds, and are propelled with an increasing impetus.

The furious blasts which sweep along from time to time during a storm, plough up the ocean, and drive on the mass of waters with augmented speed, causing their influence to be extended to a great distance in front, by reason of the centrifugal forces on the side of progression, acting with greatest energy, and more or less in the direction of the storm's track.

In this manner, waves of undulation and progression are propelled in advance of the storm, (when that is not too rapid to overtake them,) which are often noticed as heavy rollers, at a considerable distance from the source of action, while the sea is smooth, without being driven by any wind.

The *Storm Wave*, said to be sometimes particularly noticed, during the passage of the centre, may be due to the combined forces of a swiftly moving Hurricane acting on the waters confined within the central area, chiefly in one direction, as the *Spirals recurve simultaneously*, and sweep a more direct course forward on the side of progression, every one in his path, the effect of which may be to heap up a mass of waters thereabouts, and impell it onwards in the storm's track.

The central spirals, near the vortex, while they may revolve on their axis more rapidly, will be, I presume, retarded in their progress in proportion as they approach the looped side of the Hurricane, and sometimes appear to remain almost stationary.

The *Storm Current* is chiefly confined, I imagine, to the body or vortex of the storm, and may be due to the local effect of the winds upon the water, and to the centrifugal action of the storm; and on the side of progression, to a constant current or set, flowing in that direction, from behind, forwards, arising from the same cause. On the looped side of a Cyclone, the sea, though impelled with great power, can have but little progressive motion in any one direction, as the conflicting forces there in full operation, destroy or counteract each other's effects, and change the current continually, producing the confused outrageous cross sea often mentioned by Mariners, which is the principal danger to be apprehended, and which tumultuous state of waters continues, as might be expected, for many hours after the storm itself has passed away.

But who can describe the awful scene at the centre, where all the powers of the Hurricane are concentrated, and the hapless ship, caught in the vortex, seems doomed to inevitable destruction.

There, the rapid veering of the wind, and fierce spiral blasts, following one another in quick succession, lash on the foaming sea most furiously, now in one direction, then in another; and mountain waves, tossing their crests on high, dash together in the raging conflict of mighty waters.

The darkness, the fitful gleam of lightning, the roaring wind, and deafening thunder, all conspire to fill the mind with dreadful apprehensions of impending destruction; and man reels to and fro like a drunkard.

O! for a **Voice** at such an hour, to say with effect, *"Peace, be still"*!

PART III.

EXTRACTS FROM A METEOROLOGICAL JOURNAL

AND

FACTS CONNECTED WITH THE PHŒNOMENA OF WIND, UPON WHICH THE PRESENT THEORY IS FOUNDED.

The following extract from a Meteorological Journal kept at Lahore in 1850, embracing a period of about two months, is introduced for the purpose of shewing that the passage of the spiral columns is not always attended with electrical excitement.

Lahore, Aug. 19th. 1850.

Day sultry. No wind either to day or for some days past, and the stagnation of the air, night and day, is most oppressive. An unusual amount of sickness now prevails in the city and at Meanmeer the fever is of the Intermittent and Remittent types, accompanied with much prostration, and is of a more intractable form than usual. Dysentry also prevails. — The wind if any there be, is from the S. W. The nights are clear and star light — nothing remarkable about the atmosphere at night — Meteors are rare.

20th — Very sultry all day and night — cloudless sky, and hazy stagnation of the atmosphere — much fever.

21st — Sky clear at sunrise. — To the N. N. W. quarter, 30° elevation, light Cirro-strati — and sky somewhat hazy towards the Horizon, so as almost to obscure the sun at sunrise — vane points to S. by E. light air, which soon rose, and at 8. 30 A. M. it was blowing a pleasant breeze at times from the West. — The vane veering slightly to Southward.

10 A. M. — Air still — vane points to W. whole sky covered with hazy Cumuli; through a break in the clouds over head, the clouds seem to be moving in opposite directions. Dew point 80: Temp. of ext. air 91. 5 Farht.

12 M. Noon. — Wind rising.

12. 20 Noon. — Wind increasing and blowing a moderate breeze from the N. N. E. Constant passage of dust whirlwinds, from N. N. E. to S. S. W. Vane oscillating as usual during their passage.

No electricity is developed from the insulated wire; nor is the gold-leaf Electrometer at all affected, even during the passage of the electrical whirls.

3. 30. P. M. — Stormy. Dust blowing in whirling sweeps from N. N. E. to the opposite quarter. Gusty — vane oscillates strongly as the gusts pass. No indications of Electricity, which is remarkable. The wind is cool, blows a moderate breeze of 25 miles an hour or less.

4. P. M. — Dust blows strongly from N. N. E. to S. S. W. — Sky clear, and covered with a thin stratum of Cumulo-strati moving from West to East.

5. P. M. — Wind subsiding.

5. 10^{m} Blows a pleasant breeze from the same quarter.

At sun set, a distant bank of cloud was observed all round to the Western Hemisphere from N. to S.

7. P. M. — An occasional faint flash in the direction of the bank: so faint as to be scarcely noticeable.

9. P. M. — Strong breeze suddenly rose from the North, with dust blowing, and lasted 10 or 15 minutes and then nearly subsided; distant lightning is seen extending 10 or 15° above the Horizon, which dimly reveals a distant bank of cloud to the N. and N. W. Cool wind all night — no storm.

Aug. 22nd Sun rise. Cool wind blew all night and continues this morning from N. N. W. Gusts at times, but no dust-whirls observed, vane oscillates 2 or 3 points. — The whole sky covered with two layers of Cumulo-strati and Cirro-cumuli. The one below, moves from West to East. The upper strata lighted up by the sun.

9. 30 A. M. — Light breeze from E. N. E. — sky nearly clear. — A few Cirro-strati patches.

10. A. M. — Sky clear, slightly hazy; a light air from N. E. External air 91°. Dew point 70. 5. *min:* of self-regist Thermometer 75. 5.

3. 30. P. M. — Sky clear. Light breeze from N. W. — vane oscillates slightly at times.

4. P. M. — A slight air from N. W. Sky clear. Night clear.

23rd August. — Sky clear at sun rise and after — a light wind from the West, scarcely perceptible.

24th August. — At sun rise — wreaths of Cirri over sky, extending longitudinally, with the meridian. A few white cottony clouds during the day, on a clear sky.

A hot wind blowing at times — night fine.

Aug. 25th Sky covered with a sheet of fine Cirri, especially to the Eastern Hemisphere up to the Zenith. West Hemisphere nearly clear. The whole field seemed to move from W. to East, though the motion was indistinct by reason of the great height. A light air from E. S. E.

10. A. M. — Sky clear. Air still. Vane oscillates slightly. Temp. of air 96. 5. Dew point 77°. Vane unsteady — pointing W. by N. — then S. — N. and then N. by E.

10. 15. A M. — Vane points to N. E.

Day sultry — at sun set — Cirri over sky. Night clear and cool.

Aug. 26th At sun rise a light cool wind from E. by S. Sky covered with Cirri in large contorted streaks moving from S. to North, denser to the Eastern Hemisphere.

About 7 A. M. — Frequent passage of dust whirls, all moving from S. E. to N. W. No distinct columnar appearance, but on the surface the dust follows the whirl in a broad train.

10 A. M. — and before — light wind from S. E. or E. S. E. — passage of dust whirls. Sky covered with irregular patches of Cirri moving from S. to N.

Temp. of air 93°. Dew point 80°.

1. 30. P. M. and before. Masses of white Cumuli collecting to the South and East and around Horizon moving seemingly from N. to South, and as they pass over head, are seen to be in rotatory motion — above this was observed a layer of Cirri in small streaks irregulary arranged. Vane unsteady, points generally to N. E. and oscillates gently to N. N. E. Clouds in Zenith in vermicular motion, dissolving and forming again.

Kites are seen soaring high up, above a mile, sweeping large and rapid circles beneath the masses of Cumuli.

Cumuli vanish rapidly, and seem to be whirled up into a higher region out of sight, as the blue sky is not clear, but hazy.

3 or 4 P. M. — Sky overhead clear, Cumuli all round Horizon. A light unsteady wind from the N. by West. Night clear. Air stinking all night.

August 27th Sun rise gentle wind from E. S. E. Sky covered with Cirri and Cirro-cumuli and Cumulo-strati, the lower stratum moving from N. to S. The Cirri above feathery and cortorted.

10 A. M. — Light wind from East; Cirro-strati and Cumuli.

Passage of Electric whirlwinds from E. S. E. and S. E. to N. W. or W. N. W. not very strong. Sky mottled with Cirro-cumuli, which move from S. to N.

1. 15. — P. M. — gentle wind.

Large dense masses of Cumuli all round Horizon, particulary to the Westn. Hemisphe. — light cottony Cumuli moving quickly from South to North. A few minutes after vane points to N. Gloomy looking all round from W. to N. E. Dust blowing from N. suddenly. A lower Cumulus scud flying from N. to South with the wind — distant thunder to West. On looking up to zenith several (3 or 4) strata of clouds almost of a similar character move from N. to South or from South to North. Above and beyond, mottled Cirro-cumuli appear quiescent — but the glare and heat too great to observe this long.

This puff of storm lasted for a few minutes only, and left a stillness in the air.

1. 50. P. M. — Storm over.

3. 20. P. M. — fine. Vane oscillating N. and N. N. E. Clouds gathering more to N. E. — N. — and E. Hemispheres and to South: gloomy overcast to South.

Night clear.

August 28th 10. A. M. — Temp. of air 92°. Dew point 77°. Sky clear. A light wind veering from N. E. to N. — small patches of Cumuli about the Horizon to E. and West.

12. Noon — Light air from West. Sky covered with mottled Cirro-cumuli moving from S. by N. to N. N. E. or N. by E.

4. P. M. — Cloudy Cumulo-strati and Cumuli moving from N. N. W. to S. S. E. and in rolling motion.

Sun set cloudy.

Night still and very oppressively close, especially about 9 and 10.

August 29th — Time much occupied with the sick.

3. P. M. — Suddenly gusty, and the dust blowing in whirls from the S. W. to N. E. Vane oscillating as usual. Sky covered with large masses of Cumuli moving from N. N. W. to S. S. E. Sky seen beyond, clear and blue. Sky generally gloomy all round Horizon. No Electricity developed during the passage of the whirls. — A gold-leaf Electrometer is not in the least degree affected, which is remarkable; the same thing has been observed for some time past.

On rubbing the Electrometer with a silk handkerchief, the gold-

leaves were after several rubs, and sudden withdrawals slightly affected — but the leaves almost immediately collapsed, showing an absence of Electricity in the atmosphere. During the dry weather, before the rains, the slightest rub of a silk handkerchief is sufficient to affect strongly the leaves. — From this, the inference is, that the Electro-magnetic beams or spiral columns, are not necessarily electrical, though they conduct it at times. This fluid is not now developed, though the spirals are present, and their effect upon the air the same as usual; producing currents of wind. Night clear, a few light clouds about — Close — air still — vane points to S. — cooler than the night before.

Aug. 30th — Sun rise. Light air from E. contorted Cirri in long tortuous lines extending Meridian wise — N. and S. Below are seen patches of Cumulo-strati moving from N. W. to S. East. Northern quarter nearly clear. Clouds accumulating to Southward.

August 31st — Post Scriptum.

At sun rise — lengthened cirrous bands stretching E. and W. and in some parts, small patches of Cirro-cumuli.

About 3 P. M. — A sudden dust storm from the S. E. to N. W. which continued with occasional lulls and increasing gusts for some minutes — 15 or 20 — during which time the gold leaf Electrometer was not affected, and no Electricity was seen to proceed from the insulated wires.

The wind was cool and produced a very decided effect in reducing the temperature.

Driving home about 8 P. M., observed occasional gleams of very distant lightning to S. E.

Septemb. 1st about 2. 30. A M. — this morning a storm from S. E. with rain, thunder and lightning. The rain heavy and wind blowing a strong breeze from that quarter. The lightning very vivid and near. Sky overcast with light hazy cloud. Stars occasionally seen in the Zenith.

About 5. A. M. — Wind to Northward.

5. 25. A. M. — Wind N. W. and veering to Westward — vivid lightning and rattling thunder to West.

5. 40. A. M. — Wind S. E. and S. S. E. At this time, frequent rolling thunder at short distance. — Sky then overcast. At sun rise, rain continues.

5. 50. A. M. — Air nearly still — vane points to W. N. W. — distant thunder.

5. 55. A. M. — Vane points S. E. Rain increasing. Thunder near.

6. 10. A. M. — Vane to South. Vivid lightning occasionally, with rattling thunder. — Clouds breaking.

6. 20. A. M. — Vane to N. E. — light air — rain nearly ceased. Thunder and lightning ceased. Lowest Temperature min. Therm^{r}. 69°. Day continued cloudy.

Rain measured 2. 35 inches.

Sept. 3rd — Light air from E. by S. Sky covered with large feathery masses of contorted Cirri, moving rather quickly from South to North, beneath which in small patches, distributed here and there, to N. and South, are Cumulo-strati.

The cirrous cloud was denser to E., so as to obscure the sun at rising. This appearance gradually cleared off and by

10. A. M. — The sky was almost clear, only a whitish haze. Temp. of air 93°. Dew point 79°.

Since the rain, the sun's rays hot and penetrating — the air close and muggy.

4. P. M. — Whole sky covered with Cirro-cumuli and Strati and a lower scud moving from N. N. W. to S. S. E. with the direction of the wind. Low sound of thunder.

October 8th — No entry appears further, during September — probably on account of the severe sickness that then prevailed among the troops.

During the whole of September, the wind has been from a Westerly direction, — generally S. Westerly and the weather fine and sky cloudless — without indications of Electricity. No rain occured.

The winds were very light and uncertain, occasionally, the passage of a few dust whirlwinds of small size, but very rare. And it is worthy of remark, that during their passage, no development of Electricity appeared on connecting the gold-leaf Electrometer with the insulated atmospheric wire — though the gold-leaves were expanded on whipping its top with woollen fur.

The atmosphere was but feebly charged with electricity, which state continues up to the present date.

13th October. Monday. The weather continues fine and cloudless — with gentle wind from S. W. veering sometimes to E. and South. A change occurs. The air was accidentally observed yesterday to be

electrical and the hair of an Officer when combed, exhibited Electrical excitation. And the comb, when applied to the gold-leaf Electrometer, caused the leaves to expand. Lightly rubbing the glass bottle with any linen or cotton substance, caused immediate electrical excitement. The air is electrical to-day, but not to a like extent. The air has been hitherto, since the setting in of the rains, quite free from Electrical indications — so that the ordinary means of procuring that kind of excitation, failed — or when it did affect the gold-leaf Electrometer, the leaves instantly collapsed.

The last two days it has been remarked that a solution of starch and Iodide of Potassium, on white earthen-ware, rapidly became discoloured when exposed to the sun, and this was the case yesterday with some kept in the room, out of the sun's rays.

Temperature of Dew point 47°; minimum Temp. 65° *)

The spirals must be a permanent, peculiar form of matter — *they cannot be themselves* the electrical fluid — but may possibly be conductors.

October 14th About 2. 20. P. M. — A Dust Whirlwind of some size passed over the house from W. S. W. to Eastward, followed by a train of a few smaller ones. This one appeared, when at the distance of 400 yards as two columns of some size and height, but not very distinct. The Electrical conductor not affected at the time, though the air is dry and somewhat charged with Electricity; as the bottle (containing the gold-leaves) slightly rubbed with linen or cloth, is immediately attended with the expansion of the gold-leaves.

This column followed the direction of the light wind blowing at the time from the S. W. or S. S. W. (or, more properly speaking, the wind followed *it*).

The vane was not much affected after the whirl had passed, and no strong breeze was experienced.

Note: The existence of crossing currents at different heights in the atmosphere, is indicated by the opposite courses of the various cloud strata.

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*) About this period of the year a very sudden and marked reduction of the temperature is remarked in the *Dew point*, and the nights become sensibly colder, which change requires to be carefully guarded against, by the adoption of warmer clothing, and avoiding exposure to the night air; and for troops, *early* morning parades should be discontinued.

A neglect of such precautions often leads to sickness.

October 27th — Sun rise, clear, except to Westward from S. West to N. E. where Cirro-strati contorted are seen to the height of 20 or 30° moving from S. W. to N. E. with the general direction of the air at the surface — Day hot. During the day, light cool inconstant breeze caused by the frequent passage of the dust whirls; all moving in the general direction of the surface wind from S. W. to N. E.

3. 30. P. M. — The vane points to S. W. but the wind nearly dropped.

In the Northern hemisphere lines of Cirro-strati and Cumuli are seen as high as 35°.

The air dry: the temperature of Dew point 47° and the gold-leaf Electrometer is easily excited.

October 29th 1. 30. P. M. — Several small Dust Whirlwinds moving about, some of which were very distinct as the air was almost still. They all progressed very slowly, about 1½ or two miles an hour, some remaining almost stationary for a time.

Observed one moving from S. W. to N. E. composed of 6 or 8 smaller whirls, all rotating briskly — small, but distinct, and the whole revolving from right to left, the side of progression having the dust thicker. The centripetal currents of wind not perceptible, nor a train, as its progress was too slow for these to be formed, with any distinctness.

About this time, took notice of a single contorted column, which presented a distinctly columnar aspect to a considerable height, as far as the eye could reach, precisely similar to what had been witnessed before.

Nr. 1.

Uniform columnar appearance of the diminutive Whirlwind preserved throughout its entire visible height.

April 11th 1851. At 1. 35. P. M. — A Dust Whirlwind, several feet in diameter, of considerable height and distinctness, whirling from left to right passed over the house slowly at the rate of 2½ miles an hour from S. W. to N. E.; which course it pursued for about 4 or 5 hundred yards, when it deviated somewhat to the East. White masses of Cumuli, almost stationary, appear in the Zenith on a blue sky, above which is a

stratum of cottony Cirri stretching in lines from N. to East and moving rapidly to Eastward from the West. A surface zephir from the West, scarcely affecting the vane. The column whirled up large volumes of dust high into the atmosphere, and preserved a distinct columnar form and whirling motion, throughout its entire height, as far as the eye could reach, which was supposed to be about a mile — at which height, it joined a large white cottony cloud in motion, progressing in the same direction with the whirlwind.

When at the distance of about 300 yards, the column seemed to subtend an angle of 60° or more, and was judged to be about a mile high from the appearance of the *Kites* that soared above and around it. The surface wind was scarcely at all affected when once the whirl had passed — which is accounted for by the slowness of its progress.

This method of judging distances by the appearance of Kites and Crows, which are very numerous in India, and which (viz. the Kites) usually follow and soar above and around a Whirlwind column, as if in sport, was found to be very convenient and accurate.

Nr. 2.

Peculiar rotatory action and ascensive force of the Whirlwind Column.

Mean Meer, March 24th.

Numerous Dust Whirlwinds of all sizes passing from N. N. W. to S. S. E. and S. E. from 11 A. M. till 3 P. M. — Many were seen at the same time following close upon one another — that is, in the same line.

Their rate of progress was about 9 or 10 miles an hour, as fast as a horse could gallop: some turned one way, some another — many exhibited a continuous column of dust to the height of two and three thousand feet; the column was more or less wavy, and usually appeared broken for want of continuity of the dust in consequence of the rapidity of progress. As they passed along, they whirled up dust into the atmosphere with great force, for a minute or so, — then ceased for a while, the dust already raised, still ascending, and preserving its colnar wavy form as if influenced by some power which worked from below, upwards; then, after a lapse of half a minute or more, the whirling motion would recommence as furiously as ever, the dust ascending like smoke from a furnace — then again it would cease, the body of dust

meanwhile ascending rapidly as before; the same thing being repeated again and again as the whirlwind travelled onwards.

In the course of two or three minutes, the dust would have, to all appearance, ascended two thousand feet and upwards, when it became diffused, and was carried onwards in advance of the extremity in contact with the earth, a general whirling motion being perceptible in the cloud of dust above, as it passed over head.

At the height of two or three thousand feet, the whirling body loses its columnar form, and the dust is dispersed in the form of a cloud, still ascending higher and higher, till completely out of sight. Numbers of Kites follow these whirlwinds — 20 or more are frequently seen soaring about and around one of them *at different heights*, in sport.

Nr. 3.

Electricity developed in Dust-Storms; comparative conducting power of Brass and Zinc wires.

Mean Meer, March 25th.

2. 10. P. M. — Storm coming up from the N. N. W. Cloudy and stormy looking to the North — clear to South. High wind. Lower scud cloud moving rather rapidly from W. S. W. to the opposite quarter.

2. 20. P. M. — Bar. 29. 240. Att. Ther. 78°. Wind N. Vane constantly oscillating from N. to N. N. W. Clouds of dust in the Horizon, and to South, to which point it is all blowing.

2. 30. P. M. — Electricity developed from the atmospheric wires in sparks 1/4 of an inch long or more.

2. 37. P. M. — Bar. stationary. Surface slightly *convex*.

The electric fluid now streams furiously down the principal brass wire in sparks 3/4 of an inch long.

The zinc wire gives but feeble indications of Electricity.

2. 40. P. M. — Comparative lull. Sparks less — 1/4 inch long. Wind N. N. W. and veering 3 or 4 points.

Zinc wire gives no indication of Electricity, while the length of the spark from the two brass wires, is 1/4 of an inch.

2. 50. P. M. — Bar. 29. 240. Att. Ther. 77. 5. Surface convex. High wind from N. W. by N. Dark lowering arched overcast to the North — wind steady from the North. Nimbi appear. Air damp. Cessation of Electricity. Three birds flying from N. W. to S. E. were observed

as they passed to halt and turn about in the air — then whirl round again, and after taking a short flight, to turn as before, repeating this so long as they continued in sight.

The lower scud a mile high or more, moves from S. W. to N. E.

3. P. M. — Bar. same. Surface convex, a lull. Light rain. Gloomy appearance to N. much less marked.

3. 15. P. M. — Scud cloud still coming up from the S. W. to N. E. Surface wind N. and veering to N. N. W. and back again. Wind subsiding.

3. 30. P. M. — Bar. 29. 320. Att. Ther. 73°. Surface flatter. Storm passed off. After sun-set stormy looking to the N. W. hemisphere all round. Clouds passing rapidly to the East from West. A few stars dimly visible in the breaks. Clear to South, with Cirro-strati and Cumulo-strati. A pleasant breeze blows from the North.

9. 45. P. M. — Heavy clouds all round from S. W. to N. E. A clap of thunder. Air still. Shortly after, heavy rain.

10. P. M. — Bar. 29. 228. Att. Therm. 68. 8. Vivid lightning, quickly followed by loud thunder and heavy rain. Another flash, and thunder followed by pouring rain, which continued for half an hour.

In this case, an insulated brass wire was fixed to a tall bamboo outside, and brought into the tent through a glass-tube, the wire at that part being further insulated by being wound with silk covered with resinous cement.

A few feet below the top of the pole, a cross-bar was fixed, to either extremity of which was attached the neck of a glass bottle, and a brass wire on one side, and a zinc wire on the other, which were in like manner conducted into the tent, and all bound together.

Notwithstanding the insulation of the wires, strong electrical sparks passed from the side of one wire to the other during the height of the storm.

Nr. 4.

The effect of the passage of the smaller Whirlwinds on the air through which they pass.

In watching the variations of the wind during the passage of a Dust Whirlwind of moderate size (4 or 8 feet in diameter) progressing 7 to 10 miles an hour, we notice the following particulars.

Directly in front, a vane is unaffected till the whirl is within a few yards or feet of it. The vane then commonly points towards it, though we seldom experience any draught of air in that direction. When the whirl passes, the vane sways to and fro several points, impelled by contrary currents — after which a light, unsteady wind may blow in the direction of the track for a minute or so, while the column has progressed 150 to 200 yards. — The wind then rises, and continues to blow with increased strength, during which it has progressed 100 or 200 yards further.

A short lull may then take place, succeeded by a fresh breeze, which soon becomes light and unsteady and finally drops, and may rise again for a short interval. One of 3 or 4 feet in diameter, moving from N. to S. at 6 or 7 miles an hour, passed about 20 yards to East of the portable vane. When opposite, the wind blew rather strongly towards the moving column — when passed, a lighter wind blew in the direction of the whirl, and continued pretty steady till it had gone about 200 yards — when the breeze freshened to a pleasant breeze, and blew till it had made a further advance of 150 or 200 yards at an angle — not in the direct line — but as that went S. by W., the wind blew from N. N. W. After this, the wind dropped, and blew more gently from N. W. which continued nearly as long as the former one, when the wind again freshened for a short time, I think. But much difficulty attends an accurate registry of the currents under these circumstances, without the assistance of another: and repeated observation is the only way to obtain accuracy.

Nr. 5.

The Whirlwind usually composed of several separate spiral columns, each one rotating on its own axis — affects the air through which it passes, causing currents to blow in the track, — without which the air would be still. Alternate gusts and lulls caused by the passage of a succession of Whirlwind-columns moving in same direction at intervals. Strength of wind depends upon the velocity and rotatory energy of the spiral column.

Mean Meer. March 1851.

A Dust Whirlwind was noticed, 20 feet in diameter, moving at the

rate of 6 or 7 miles an hour, from N. W. to S. E., composed of several spirals, each one of which whirled on its own axis.

A vane in front became slightly affected when within a few feet of it, and pointed towards it, and when the vortex passed, was twisted about violently.

A light wind then blew for 150 yards, followed by a lull. — It then freshened and blew stronger and stronger for 200 yards further, or more — then followed a complete lull, and then again, it blew as strong as before — this being repeated more than twice, without the passage of another spiral in the interim. — It turned from right to left and as it passed, the curved lines of dust on the side of progession were distinctly seen.

Sky covered with large masses of Cumulo-strati. — Numerous Dust Whirlwinds passing in the same direction. No wind perceptible but that caused by the passage of the Whirlwinds.

They are observed to come on at intervals; and then there is a period of complete cessation.

Nr. 6.

Mean Meer. March 28th 1851.

A Whirlwind of small diameter passed East by S. from the opposite quarter. It turned from left to right. When at the distance of

200 yards wind blew strong — then a lull
400 „ strong
600 „ „ and gusty
800 „ strongest
900 „ gusts and veering
1000 still strong „ gusty
1200 strong
1500 veering several points

latterly wind blew from the S. W. and veered about 4 to 8 points.

Nr. 7.

March 15th 1851. 1. 15. P. M. — Numerous Dust Whirls all moving rapidly 10 or 25 miles an hour, with the wind, which blows from N. by West.

1. 45. P. M. — A constant succession of Dust Whirlwinds passing rapidly, 15 miles an hour, from N. N. W. to S. S. E.

There are intervals of a few minutes free from the Whirlwinds — the whole extent of the horizon whence they come, is filled with a line of them, advancing together.

When they progress as rapidly as they do to-day, little can be perceived of their peculiar nature; as the dust they whirl up is diffused into an irregular cloud, and left behind, as the W. Wind advances. Sky covered with a mass of Cirri.

Memo: The rising and falling of the wind in storms, is perhaps attributable to the passage of a number of these Electrical spirals, or Whirlwinds, now moving before us, which come at intervals and are attended by a marked rising and falling of the wind.

The cirrous cloud in rapid motion, coming up from the S. W. and is carried to the opposite direction.

2. P. M. — and after. Dust Whirlwinds continue to blow from the same quarter and increase in size and number.

Nr. 8.

February 8th 2. 15. P. M. — A light breeze blows. A few small indistinct Dust Whirlwinds are moving with the wind — most of them going 7 or 8 miles an hour.

3. P. M. — Followed one on horse back for half a mile, going about 7½ miles an hour — several Kites following it, soaring at the height of 3 or 5 hundred yards above the earth, as if in sport. — The whirl rotated from right to left, and as it progressed, drew into its vortex lines of dust in tangents very distinctly.

Nr. 9.

Another day. Six or eight Vultures or Kites are seen soaring a mile overhead in the cloud of dust raised by a Whirlwind.

The wind rises and falls during the passage of these Dust Whirlwinds.

The wind freshens to a pleasant breeze for a few minutes and then lulls. One was observed going at the rate of 12 miles an hour — as it passed, it divided, and continued to progress in a smaller whirl of dust.

Nr. 10.

To day, they all follow the direction of the surface wind from South to North, some at the rate of 15 or 20 miles an hour, — others

much slower, 6 or 12 only — but most of them travel about 10 miles an hour. They do not always preserve the same pace throughout their course. There are intervals when none are to be seen: then, after a few minutes, several are seen, advancing together from the same direction — a few smaller ones sometimes going in advance. This disposition of the columns, may account for the alternate gusts and lulls, that constantly occur during a storm.

The wind seems to blow more forcibly and steadily after the whirls have moved on 2 or 3 hundred yards; or, from 40 seconds to a minute, according to the rate of progress. After passing, a short lull takes place, followed by a gradual increase of wind, till at the distance of 2 or 3 hundred yards, the wind blows strongest.

Nr. 11.

At 1. P. M. — Another day. Six dust columns of various sizes are seen at 2 miles distance, coming up from the same direction — N. W., from which quarter a pleasant breeze blows — the wind is too high to notice distinctly their revolutions — and they for the most part exhibit merely a train of dust impelled by the wind, the columnar form being in a great measure obscured.

Followed one for a mile and a half, which kept in advance, as it went steadily 10 or 11 miles an hour. It was a column of irregular form, the dust of which was carried up into the atmosphere to the height of 14 or 17 hundred yards.

Nr. 12.

The small Whirlwinds are composed of several eddies, which, on close inspection, are found to be distinct spiral columns, each one a miniature Whirlwind, rotating on its own axis, round and round the Whirlwind Vortex.

14 March 185I. A Whirlwind 30 or 40 yards in diameter, rotating from right to left, contained in its circle many distinctly formed spiral eddies, each eddy having attached to it a curved stream or tail of dust which, whatsoever position of the whirling circle it occupied, retained its relative position as regards its own individual rotatory and

progressive movements. On the right side or side of progression, the dust accumulated, and obscured the eddies. Plate 2. Fig. 1.

Nr. 13.

Another Whirlwind, 10 or 12 feet in diameter, going at the rate of 6 or 7 miles an hour, was observed to be composed of distinct columns.

Nr. 14.

Mean Meer, Oct. 29th 1852.

12. 30. P. M. — The air still. Sky clear. A ring of spiral columns are seen rotating from left to right — consisting of 15 or 20 separate spirals, forming together a distinctly whirling ring — they progressed at a very slow pace, at one time, not faster than a mile an hour. Became very distinct, while moving over a light dust soil. The separate spirals cannot be traced to a greater height than a few feet above the surface, — one of them would occasionally shew more distinctly to 8 or 10 feet. Plate 2. Fig. 2. They were all exactly the same size, in the horizontal section — and it may be remarked, that whenever the ultimate spiral column has been seen, it has invariably presented the same aspect as to size and columnar form.

Nr. 15.

April 16. 9. A. M. — A Dust Whirlwind of considerable size, 5 or 6 hundred yards in diameter, suddenly made its appearance from W. S. W. and passed on to the N. E. after progressing 2 or 3 hundred yards, the South whirl recurved and skirted the house. The rotation was from left to right.

At the same time, several small whirlwinds swept pass. The main whirl was, when at the distance of 5 or 6 hundred yards, divided into two principal columns of dust; one to the N. the other to the N. E.

During the passage of the whirlwind, the vane continued to oscillate in every direction, from E. round to W. by South.

The wind not affected beyond the immediate vinicity of the whirl, or beyond the distance of 2 or 3 hundred yards. Two other dust columns observed to the South, 3/4 of a mile distant.

Nr. 16.

Electrical state of the atmosphere during the passage of a Dust Storm of moderate dimensions and energy. Wind in the storm proved to be occasioned by the passage of the whirlwind columns. A display of shooting stars on the night of 20th April 1851.

April 16. 1851. 10. 25. A. M. — Wind rising to a pleasant breeze from W. N. W. and veering to N. W. Stormy to N. and overcast all round.

1. 10. P. M. — Light wind from W. S. W. overcast and arched to North and N. E. Nimbi and Cumulo-strati. Light rain commences.

3. 45. P. M. — Moderate breeze from N. E. Arched overcast with Cumulo-strati and Nimbi. Frequent gusts from N. E. Vane oscillated 4 points or more from E. to N. as they passed.

The gusts are observed to be accompanied with dust whirls, which traverse the earth from N. E. to N. W. No columns are seen, only a little scattered dust.

5. 50. P. M. — Dust storm from N. E. and Electricity developed from the atmospheric wire. Gusts pass. A constant succession of dust whirls from N. E. to S. W. which cause the vane to oscillate strongly from E. to N. Horizon to N. E. obscured by dust. High wind and stormy.

The clouds high up, overhead, move from West to East.

Memo: It is clear, the gusts in storms are occasioned by the passage of a succession of Electrical spirals. It was observed on this occasion, that the Electricity was but feebly developed from the two wires — one of brass, the other of zinc, connected with the cross-bar placed at right angles to the upright pole, carrying an insulated brass wire, which latter gave a constant stream of Electricity ½ an inch long, while the other two wires, placed below it, gave only a feeble spark.

9. P. M. — Pleasant breeze from E. N. E. The whole sky covered with Cumuli in broken masses, moving from West to East.

April 17th. 6. A. M. — At sun rise, the whole sky overcast with Cirro-cumuli and Strati, with banks all round.

The foggy Cirro-cumuli in the zenith, examined attentively, are observed to move slowly from South to North. A light wind blows from N. by W.

10. A. M. — Bar. 29. 004. Att. Ther. 78°, very low and falling. Sky overcast. A light unsteady wind from N. W.

10. 50. A. M. — Rain. Unsteady wind from N. Sky overcast to E. and N.

11. 5. A. M. — Rain continues. Electricity developed in the insulated wire ever since the rain. Sparks $\frac{1}{8}$ of an inch or more at times. Wind N. by E. and veering 2 points.

11. 7. A. M. — Electricity ceased. Rain continues. Thunder occasionally heard.

11. 15. A. M. — Rain ceased.

11. 35. A. M. — Bar. 28. 976. Att. Ther. 80°. Light wind from N. by W. overcast.

1. 20. P. M. — Bar. 28. 952. Att. Ther. 80°. 5. Atmosphere obscured with dust in the N. Hemisphere. A light uniform overcast pervades the sky. Moderate breeze from N. Vane constantly oscillating from N. by E. to W. N. W.

2. 30. P. M. — Bar. 28. 930. Att. Ther. 81°. 5. Gusty. Wind N. N. W. oscillating from that to West.

3. 15. P. M. — or about then. Wind west, rising in gusts, during which Electricity appears at the extremity of the wires. Vane oscillating rapidly to West.

Electricity manifested in proportion to the violence of the gusts. Atmosphere much obscured by dust to the N. E.

Memo: The two wires on the cross-bar were taken down from the pole, and now lie on the roof above. Minute sparks $\frac{1}{20}$ of an inch are given off from them, while the sparks proceeding from the pole wire, are half an inch long.

3. 40. P. M. — Bar. 28. 926. Att. Ther. 81°. 5. Wind gusty, oscillating from W. by S. to N. N. W. Electricity continues to pass down the conductor uninterruptedly.

3. 50. P. M. — Temperature of air 84°. Dew point by Daniell's. Hyg. 60°. Gusty. Electricity continues to stream down the wire. Vane from W. to N. N. E.

Atmosphere filled with dust to Eastward; much clearer to Westward. Cirri and Cumuli seen overhead.

5. P. M. — and after. Wind gusty and electrical. The electrical spirals are seen at times distinctly as they whirl up the dust in passing from N. W. to S. E. The hollow whistling sound heard within doors, is not heard without in the open air; scud cloud high in the zenith moves rapidly from West to East. Horizon to the Eastward and N. E.

dusty. Sky covered as with a veil of cirrous cloud, giving it a pale whitish blue; below that are light masses of Cumuli.

About 5. 30. P. M. — No Electricity from the wires. A partial lull. Wind blowing from N. W. and vane still oscillating from W. by S. to N. W.

6. P. M. — and after. This storm cleared off before sun-set and the wind dropped.

9. P. M. — Air still.

April 18th. Light Cirro-strati overcast at sun rise. Pleasant breeze from N. N. E. raining to Eastward. Bar. rising.

9. 30. A. M. to 10. A. M. — Bar. 29. 082. Att. Therm. 76. 5. Air 77° (Min. Regist. 68°). Light wind from S. E. Vane oscillating to S. and S. S. E. About 10 A. M. in the Zenith at an altitude of 3 or 4 miles, a thin stratum of cottony Cirri spread out, moves from S. W. to N. E. Above that is seen more opaque contorted cirrous masses, rolled up in feathery branches, apparently still, but more attention shews that the whole is carried onwards from West to East. Weather fine. A light surface wind from S. to East.

Memo: The rolled whirls of Cirri, are similar in appearance to those that have been observed crowning the summit of a dust column.

Five minutes after, these light scud clouds were observed to be moving rapidly from N. W. to S. E. Surface wind at the time being from S. S. E. In the N. E. Hemisphere arched strati, and banks of clouds.

10. 10. A. M. — Lower light scud moving rapidly as before from S. S. E. to N. N. W. A light stratum of scud above moves in an opposite direction, viz., from N. N. W. to S. S. E. and at the same rate. The two strata being probably nearly on the same plane, not more than $^1/_2$ a mile apart.

3. 30. P. M. — Light air from South.

Whole sky covered with Cumulo-strati.

7. P. M. — Cloudy and stormy looking all round, especially to the W. Hemisphere, distant lightning to S. W. Unsteady Wind from W. by S. veering round to N. Wind rising — Storm coming up from S. W. A smart shower fell between 7. & 9. P. M.

10. P. M. — Rainy looking all round. Light air from West. Distant lightning from S. W. Sky overcast with Nimbi. Thunder, lightning and rain during a great part of the night, from 11. P. M. till about 3. 30. A. M.

April 19th. Heavy rain, thunder, and lightning seen to Westward. Sun-rise, sky clear save in the N. E. Hemisphere, where a bank of clouds appears 15° or 18° above the Horizon. The body of the storm has passed. Bar. 29. 122. Att. Ther. 73°. 5. Gentle breeze from N. E.

8. A. M. — Fine weather. A light stratum of Cirro-cumuli, 4 or 5 miles high, moves rapidly from South to North. Light surface air from N. E., in which direction the chief mass of cloud is seen. 1 inch of rain fell last night.

9. 30. A. M. — Light air from S. E. the Cirro-cumuli stratum still moves to N.

10. A. M. — Bar. rising. Temp. of air 77°. Dew point 65°. Light easterly wind. Clouds moving as before from S. to N.

3. 55. P. M. — Light N. W. wind; vane oscillates slowly to N. and back to N. W. Whole sky covered with Cirri much contorted and brushed up. Banks of Cirro-strati and Strati all round. Upper Cirri move from S. to N.

About sun-set, cloudy, distant lightning to S. E. as yesterday.

9. P. M. — Thunder audible in the distance.

9. 30. P. M. — Distant lightning to the E. by S. Dark clouds in the zenith, and occasional flashes of lightning and thunder from that part of the sky. Light rain. Vivid thready lightning in the N. W. — flickering and lingering for a second or more on the sight, followed in 10 or 11 seconds by loud thunder. Distant lightning to East.

10. 10. P. M. — Distant lightning to E. by N. No thunder audible from that quarter. To the S. W. and W. by S. vivid thready lightning at intervals of 5 or 10 minutes, low in the horizon, distant 64 seconds, showing a distance of about 13 miles. Gentle breeze at times.

At 9. 30. P. M. — Electrometer not affected.

20th April 1851. Sunday.

21st — on the night of the 20th a great many shooting stars appeared at 9. or 10. P. M. every few seconds, in all directions. Their course, with rare exceptions, was from North to South, the general direction being from N. E. to S. W. They described a perfectly straight course, and in some instances, slow — so that 2 or 3 seconds elapsed, ere they had run their track over an extent of 80° or 90°, which would lead to the supposition that they were not far removed from the earth.

Some of them were like Roman candles, and left a luminous

train, which lingered for many seconds; — in two instances that were noticed, a minute or more; becoming gradually fainter and fainter, and in one case, the faint luminous track became wavy.

This lingering of the train, was observable more or less in most of them: in some, it was more marked.

A very few small stars, shot across the sky in an opposite direction or athwart the general direction. Sky cloudless. A faint whitish appearance to the N. E. horizon, which may have been the cirrous cloud that afterwards appeared in the morning dawn.

These shooting stars seemed to be in the region of the Cirri, but not higher than from 2 to 5 miles.

3. A. M. — Moon shining. Cirrous clouds visible. No appearance of shooting stars now. Air still.

Memo. The air was still last night. A vane pointed to N. by E.

Several hundred shooting stars must have passed within sight in the course of an hour; from past 9 till after 10 P. M. they were seen from every quarter of the heavens — more frequently at first from a point 30° above the N. E. horizon. They afterwards shot out from every part of the sky. Almost all had a Southerly course. Light masses of Cirri are now seen to the N. E. and S. W. hemispheres. The Zenith nearly clear of them. Those to N. E. are faint and in detached masses — a larger body of them to the S. W. They stretched in parallel lines S. E. and N. W., and seemed to have moved from the N. East.

Nr. 17.

Centripetal currents surrounding a Whirlwind, are sometimes seen to be considerably *prolonged on the side of progression, that is, the side corresponding to the working of rotation and of progression.*

Mean Meer, March 31st, 1851.

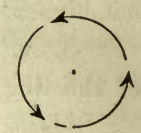
Day sultry. A light Wind from N. W. At Noon and after, numerous Dust Whirlwinds appear, all progressing in the same direction, from N. W. to S. E.

1. P. M. — Sky clear. A low white bank of cloud to S. E. 12° above the horizon.

A Kite is seen soaring above at the height of at least 1500 yards, under the cloud of dust, raised by a Whirlwind, which cloud is seen far above it.

The cloud is diffused, and in rotatory motion, just like the white masses of cottony cloud, so frequently seen to form and then speedily dissolve and vanish, and become transparent. A small Whirlwind, going at the rate of 8 or 10 miles an hour, slightly affected a vane at the distance of 10 paces when opposite to it, and raised a gentle current of air, unsteady and veering 2 or 3 points, till it had passed to the distance of 400 yards, when it suddenly blew a strong breeze from N. W., in the direction towards which the whirlwind column was moving, and continued to blow steadily for some minutes longer, when it veered, became unsteady, and finally dropped.

About 4. P. M., at which time the whirlwinds usually subside at this season, — one, four or five feet in diameter, swept by rather rapidly from N. W. to S. E. rotating from right to left.



On the north side (whence I viewed it from my buggy at the distance of a few paces,) no streams of dust were perceptible though the whirling ring of dust was perfect, while on the *opposite side,* corresponding to the working of rotation and of progression, strong converging currents of dust, extending to a considerable distance (that is, several yards) from the whirling body, blew almost at right angles to the line of progression, continuing to do so, till out of sight; and what was most remarkable, the train of dust kept up with it as it moved rapidly onwards in its course. Plate 11. Fig. 1.

The unequal duration of the opposite sides of a Cyclone, may thus admit of explanation.

Nr. 18.

The whirling circle or ring of dust formed by the smaller Whirlwinds at the earth's surface, is often seen to be composed of a number of eddies of uniform size, which appear to be separate Spiral Columns, each one rotating on its own axis, and performing a gyration with the body of the whirl.

14th. March 1851. Cirrous scud, high in the atmosphere, passing rapidly from West to East. Two Kites seen soaring together at the height of 14 hundred yards. Cirri are observed far above them.

This lower bright scud, which possesses a rotatory motion, is considerably below another stratum of contorted Cirri.

A constant succession of Dust Whirlwinds, all moving with the wind, at the rate of 8 miles an hour. One of them, rotating from right to left was observed to be most distinctly formed of a number of separate whirls or spirals, and on the side of progression, the dust accumulated, while the opposite side was comparatively free from it.

Each spiral rotated on its axis as it went round and round the whirling ring or cycloid, and had attached to it a small curved train of dust, which always preserved its relative position being affected precisely in the same way as the Whirlwind itself is.

It was curious to observe that as each spiral eddy came in succession to the rear — towards the side which was moving in its rotation in the same line with the track, is seemed endued with increased rotative energy, shewn by a larger train of dust and swifter motion. Plate 2, Fig. 1.

Memo: This phœnomenon has often been witnessed with more or less distinctness.

Nr. 19.

Two Dust Storms of moderate powers, but not very characteristic; and the electrical condition of the atmosphere during the time. A slight shock of an earthquake experienced on the 11th of May 1851 and on the 13th a dark spot seen by the naked eye, on the sun's disc (upper limb) at sun rise.

Lahore, May 10th., 1851.

Last night the air still. The clouds in the Zenith noticed at 6. 7. and 10 P. M. to be moving slowly from South to North. At sun rise — this morning, the sky overcast with Cumulo-strati, denser to the N. N. W. Clouds moving slowly from S. S. E. to N. N. W.

Sun in rising pale and white, emerging from out of a thin hazy bank. Swallows flying at a considerable height. Air still. Vane points to N. by W.

7. 30. A. M. — Whole sky overcast. Nimbi to the N. W. broken to Eastward and South, but more uniform to W. and N. N. W. Air still. Vane points to N. and slowly veers to N. N. W.

A light shower of 2 or 3 minutes duration occured about this time.

10. A. M. — Air still. Vane to N. W. hazy overcast. Sun shining.

1. 30. P. M. — Vane veering slowly round to South.

2. 5. P. M. — A. Dust Storm coming up from the S. S. E. not very rapidly. It occupies abont 6 points of the horizon, with dust driven to the height of 50 or 60 degrees. Wind light and unsteady. Plate 8.

2. 10. P. M. — Electricity developed from all three wires. Sparks issue 1/4 of an inch long, accompanied with a crackling sound. The atmosphere filled with light dust. Vane oscillates a good deal from South to S. S. W. and S. by E.; high Cumulo-strati to the S. and N. W. Gentle wind from S. W. — veering.

2. 30. P. M. — Sparks more than 1/2 an inch long, and jagged as usual. Moderate breeze oscillating much to E. by South.

2. 45. P. M. — Atmosphere more obscure. Gusty — vane oscillates to S. E. and back to South. Sparks 3/4 of an inch long.

2. 50. P. M. — clearing.

3. 15. P. M. — The storm has cleared off in a great measure. Wind S. by W. or S. veering slightly. Electricity still apparent, but much diminished.

4. P. M. — Storm passed off to N. N. E. Sky covered with hazy Cumulo-strati. Light wind from S. E. At sun-set, Cumulo-strati collected about the N. Hemisphere and other parts.

9. P. M. — Sky covered with Cumulo-strati moving slowly from S. S. W. to N. N. E. A light wind blows from E. N. E.

11th May. 3. 19. A. M. — A slight shock of an earthquake which lasted about 10 seconds.

12th May. Monday. Sky clear at sun rise. Air cool from yesterday's Dust Storm, which came from the S. W. about 2 P. M. and lasted for half an hour or more, during which time, the Electrical fluid passed down the insulated wire uninteruptedly, the sparks being 3/4 of an inch long at times.

The two other wires, brass and zinc, placed a few feet below the main wire, gave comparatively feeble sparks, never more than 1/4 of an inch long, and both much the same.

The vane oscillated a good deal as usual, especially during the gusts. Suddenly all Electricity ceased, on the fall of a few drops of rain, about which time, low thunder was heard and after that, several times, when more rain fell.

After this the wind shifted to East and then to N. E. During the storm, the sky was overcast with light Cumulo scud.

A delightfully cool refreshing breeze accompanied this storm, and continued all night.

10. A. M. — Bar. 28. 864. Att. Ther. 81°. 5. Air 88°., light wind from W. Sky clear. A few contorted Cirri to the N. low in the horizon. Occasional passage of Dust Whirlwinds.

Noon. Sky clear. Wind rising in gusts from the West. A few small white detached clouds in various parts of the sky, especially to the W. horizon.

4. P. M. — Pleasant breeze blows from West. Sky clear, save a few small white detached clouds.

May 13th. Soon after sun-rise, a dark spot was seen on the sun's disc, about the midde of the upper limb, midway between its Equator and pole.

Memo: A similar appearance has often been seen before on the sun's disc, when low in the horizon, at sun rise or sun-set, and its rays are partially subdued by the prevalence of fine dust in the atmosphere, which is of frequent occurence during the dry months. Indeed so frequently has this been witnessed, that the eye naturally looks for it whenever the sun is visible under the same circumstances.

Memo: During the continuance of some storms, when thunder and lightning occur, a gold-leaf Electrometer connected with an insulated wire, comports itself as usually described in books. The leaves expand — but a flash — and instantly they collapse, and remain so: presently, we see them gradually, or suddenly, unfold and expand as before — and we wait in expectation for the flash — when they again instantly collapse.

Nr. 20.

May 20th. 2. 27. P. M. — A Dust Whirl some yards in diameter passed from S. S. W. to N. N. E. at the rate of 7 or 8 miles an hour, which, as it swept over the house, strongly affected the conductor, which elicited sparks $^1/_{10}$ or $^1/_8$ of an inch long. The column was very lofty and wavy, but could not be distinctly observed on account of the extreme heat and glare. Temperature 108° in shade, 138° in the sun. Several Dust Whirls had passed before, but were not so marked or so large as this one.

Sky covered with patches of white cottony clouds. This Whirlwind, while in the act of passing, caused the vane to veer about; and after it had passed to the distance of 2 or 3 hundred yards, the vane oscillated from S. S. E. to S. S. W. affected by the after-currents.

Nr. 21.

The smaller Whirlwinds *seem* sometimes to reverse their rotation, and to be subject to other remarkable changes in their rotatory movements.

Mean Meer, Januar 21st 1853.

About noon, observed a few Dust Whirls of small size, moving rather slowly, but varying in velocity; now, nearly stationary — then, starting forwards at the rate of from 3 to 6 miles an hour: sometimes working in a condensed form of 3 or 4 feet in diameter or less — then the same one would spread out, and form several distinct small Whirls, preserving a cycloidal gyration and progression in the original direction, which was from N. W. or N. N. W. to S. E. or S. S. E.

One was observed when in a condensed form, to make several changes in its rotations, — from left to right, and from right to left, in the space of 2 or 3 minutes, while I was driving towards it over dry dusty ground, covered with scanty vegetation.

The phœnomenon had never been seen so distinctly before, and doubts were entertained whether the appearance of reversing the rotation (which is seen to take place suddenly) were not an optical illusion; there was in this case, seemingly, no mistake.

The day was fine, with Cumulo-strati on a clear sky. No *wind* blowing at the time.

ZODIACAL LIGHT.

Nr. 52.

The *Zodiacal Light* may be seen at Lahore night after night in the South Western Horizon, about an hour or more after sun-set, when the moon is not shining, during the early part of the year and

late in Autumn from that time forward, and sometimes in the opposite quarter of the heavens before the early dawn.

It presents the same appearance as described in books.

A faint lenticular spear-shaped pyramid of nebulous light, like that of a comet's tail, rising obliquely at an angle of 70°, or less, by a broad base, from the South Western Horizon, pointing to Pleiades and extending sometimes up to the very Zenith.

It is seen in the evenings with most distinctness, as far as memory serves, during January, February and March, following the sun in annual course, North and back again to South, according to the seasons, becoming, as summer advances, gradually merged in the twilight.

The general direction of the axis seems to pass through the sun, "suggesting", as others have said, "the idea that it is something attached to that luminary, having an apparent motion due to the same cause, viz. the motion of the earth in its orbit."

Mean Meer, 14th. Sept. 1853.

4. A. M. — The sky being perfectly clear, and no moon visible, the *Zodiacal light* was very distinctly seen in the E. N. E. rising with slight obliquity to South towards the Zenith, and pointing nearly to Pleiades, which are at this time a little South of the Zenith, and to Westward.

It may be distinctly traced up as high as 40 or 50 degrees, when it meets the Milky-Way, and is lost.

It rises by a broad base, but soon tapers; precisely of the same character as was noticed in the Spring in the opposite quarter of the heavens, after sun-set.

The Zodiacal light was still distinctly visible half an hour after this; but then rapidly merged into the dawn.

Seems to be on a plain with the Sun's axis.

Was looking for the Comet in this quarter, without success.

September 15th. 4. A. M. — Night clear. The Zodiacal light is seen very distinctly rising at an angle with the horizon to the E. N. E. and extending up to the Milky-Way to about 60° or more.

Appearance precisely similar to what was observed on the previous morning.

On the way to Peshawar in November 1853, the Zodiacal Light was most distinctly seen in the South Eastern Horizon before the early dawn, rising to a great height in the sky.

Kalabag. R. Indus. Dec. 14th. 1854.

7. P. M. — The Zodiacal Light seen rising from the S. W. Horizon, by a narrow line of nebulous light reaching nearly up to the Zenith. Jupiter, or one of the larger Planets, is now exactly within the body of this light.

Jan. 6th. 1855. Beyond Sewan, R. Indus. 3/4 of an hour after sun-set, the Zodiacal Light seen in the S. W. very distinctly. Appears unusually slender, the base being not much broader than the body; and extends nearly to the Zenith.

Jan. 9th. One and a half hour after sun-set. Zodiacal Light distinctly seen rising from the W. S. W. by a broad base of diffused light which tapered to a narrow band rather abruptly.

The above meagre account is chiefly from memory, most of my notes having been torn up, under the impression, that the observations being conducted without instruments, and described in plain English, were without interest to Science.

POSSIBLE CAUSE OF THE ZODIACAL LIGHT.

If it might be allowable to risk an opinion as to the possible cause of the *Zodiacal Light*, I would say, it was produced by the rotatory and progressive motion of the sun in space, acting upon the Ætherial medium, and causing, on one side especially, luminous centripetal currents towards that luminary in its Equatorial plane, just as we see the air is set in motion round about, by the action of the Whirlwind. The principle on which this idea is based, may be applicable throughout the universe of matter.

Nr. 23.

Memo: A simple and expeditious method of obtaining the Dew Point when Ice is procurable, (as it generally is at most of the large Indian stations) is to plunge a common thermometer in a little pounded ice, — let it run down 30° or 40° — take it out, wipe it dry with a soft handkerchief, quick; — hold it up to

the light, and observe the *bright spot* on the bulb, — and continue wiping off the film of dew so long as it forms, and dulls the *spot*. The instant it clears, mark the temperature.

This has been frequently compared with Daniell's hygrometer, cooled by *chloroform*, the only fluid that can be employed with advantage in India during the hot weather, and found to correspond with considerable accuracy.

The greatest depression of the *dew-point*, obtained by Daniell's hygrometer, was never (at Lahore) more than 35° to 38° Far. below the temperature of the surrounding air, within a room into which the external air had free access.

Indeed it is impossible to reduce the temperature of the black bulb lower than that by means of chloroform, much less by æther.

This great depression occasionally takes place during the hot dry months preceding the rain.

Nr. 24.

The amount of Daily Evaporation was obtained by the following method.

A white earthen-ware cylindrical blood-porringer was filled with water to a certain point, which was accurately marked, and them *counterpoised*. One inch was now measured from the surface of the fluid, and marked all round on the *inside*.

It was then filled with water up to that point, and again weighed; the weight of the inch of water was noted, and divided into a hundred parts, and a table constructed for the convenience of daily reference, thus. The inch of water weighed, suppose 5050 grs, which divided by hundreds gives 50 grs for each hundreth of an inch, and the rest tells its own tale. 50 grs deficient, shewed that the evaporation had been $^1/_{100}$ of an inch.

250 grs = $^5/_{100}$ = 0,05
1262 „ = $^{25}/_{100}$ = 0,25
2525 „ = $^{50}/_{100}$ = 0,50

The meteorological table in the book of Plates, exhibits the mean monthly amount of Evaporation for 12 months, at Lahore and Mean Meer (7 miles distant) obtained by this method.

Nr. 25.

Memo: Being without a Sextant, recourse was had to the following expedient, for determining approximately the height to which the dust was carried into the atmosphere by the Whirlwind in a columnar form.

The eye became familiarised with the appearance of Kites and Crows at different distances, by which means, I was enabled to determine to what height in the air they soared, when following a Whirlwind column, as they constantly do in sport — whirling round and round about it, at a high elevation, enjoying, may be, the opposite currents of wind to which they are thus exposed.

Nr. 26.

How Volcanic Eruptions may cause Storms.

Many observers of note, are of opinion that Volcanic Eruptions are often accompanied by violent storms and heavy falls of rain.

If we admit the existence of a stratum of Electro-magnetic spiral bodies floating in the higher regions, violent volcanic concussions of the atmosphere at great elevations, would necessarily cause the upper currents to be diverted downwards, towards the point of excitement, and bring with them the spiral bodies of which the Whirlwind is composed.

VARIOUS MATTERS RELATING TO THE WHIRLWIND COLUMN — ITS CONNECTION WITH WIND AND STORM.

March 28th, 1851. 1. A. M. — Sky to S. Eastern Hemisphere beyond the Zenith, covered with Cumulo-strati, which have spread from S. E. where clouds are heaviest. Only part of sky clear, is 8 or 10 points to N. W. Air still — vane points to N. N. E.

About sun-rise. A bank of Strati to S. E. occupying 14 points of Horizon N. N. E. to South — light air from N. E. This bank of cloud continued stationary till about 8 A. M., when it began to extend itself towards the Zenith.

8. 30. A. M. — Light air from South — sky nearly clear. Temp. of air 82° Farh. Dew point 57°.

Noon. Dust Whirlwinds moving from W. N. W. to E. S. E. at the rate of 8 miles an hour. Pleasant breeze from W. and W. N. W. Sky clear, with bright, scattered Cumuli, and all round Horizon, Cumulo-strati, specially to Western Hemisphere. Some Dust Whirlwinds are seen 1000 yards off, subtending an angle of 45° it was supposed. The mirage distinct. The clouds have a motion throughout and move from W. by S. to the opposite quarter.

3. 30. P. M. — Thunder. Five minutes after, another rolling thunder clap, followed by others. Light air from S. W. Sky covered with Cumulo-strati, and several strata of clouds rather low. Numerous Dust Whirlwinds of various sizes passed since noon, all moving much in the same direction — first from N. W. to S. E. — Latterly to E. and after that again North of E. Thunder proceeds from a large mass of cloud to the N. W.

3. 45. P. M. — thin lower stratum of cloud passes from S. to N., — above that, a light cloud curling at the edges moving from N. to South. Vane points to N. W. Is raining in that direction. Several small dust columns seen in that direction in the distance.

4. 10. P. M. — The distant storm moving Eastward, round by N. W. — numerous Dust Whirlwinds to the North, preceding it; low thunder.

4. 20. P. M. — Vane points to N. W., oscillating. Storm coming on with numerous Dust Whirlwinds, filling the whole Horizon to N. W. Storm occupies 8 or 10 points of Horizon.

4. 23. P. M. — Dust storm: Electricity in sparks from the insulated wire.

4. 25. P. M. — Suddenly all the crows in camp, (hundreds of them) fly off to N. W. Wind rising and blowing from N. W. heavy clouds in that direction and Dust Whirlwinds all about, filling the air below and under the storm.

4. 30. P. M. — Lower clouds move from N. W. to S. E. the mass of Cumulo-strati above, move from S. E. to N. W. Atmosphere to S. E. filled with Dust Whirlwinds

4. 45. P. M. — Storm has passed on the North of the camp. Clouds moving in that direction. Wind N. W. rising at times and gusty.

5. P. M. — Rolling thunder to N. E., light breeze to N. W.

5. 18. P. M. — Wind N. veering to N. by W., pleasant breeze, with occasional gusts. Rolling thunder continues.

5. 30. P. M. — Sudden shift of wind to N. E. and dust blowing now in that direction.

At sun-set, stormy to the N. E. and lightning indistinctly seen — no thunder audible. The storm continues to travel round to E. and to South — and the Nimbi soon spread from N. to South. Lightning along the line in several points.

7. P. M. — Lightning to the S. E., which now appears to be the position of the storm, having travelled 8 points Southerly since sun-set. No thunder heard, though the lightning is vivid and of the forked kind — but distant. Air still, vane points to N. South, Western quarter clearer; Star-light over head. Lightning continues to S. E. Zenith clear — stars shine with peculiar brilliancy. Cloudy all round the Horizon.

7. 40. P. M. — Pleasant breeze from N. E. — storm travelling round to South.

Thunder faintly audible.

8. 20. P. M. Wind rising from E. veering to South. Dark masses of cloud coming up from S. E.

8. 30. P. M. — Wind rising. — Brisk gale. Bar. 29. 124. Att. Ther. 73°. Surface convex.

9. 10. P. M. — Bar. 29. 142. Att. Ther. 72°. Surface convex. Wind S. E.

9. 27. P. M. — Wind increasing to a brisk gale — from S. E. oscillating to S. and back again. Zenith with light cloud; very gloomy to S. E. — nearly clear elsewhere.

10. 30. P. M. — Air still. Storm passed off — remainder of the night, still.

29th March. Sky clear. A gentle breeze from S. by E. A low bank of Strati to the N. W. and smaller ones to S. by W.

9. A. M. — Dew point 56°. Temp. of air 75°. Sky clear — gentle breeze from N.

Noon. Sky perfectly clear. Not a cloud to be seen — pleasant breeze from N. No Dust Whirlwind observed as yet. Mirage observable. The motion of the air over such places very perceptible — transparent and tremulous, like rarified air over a furnace, or brick-kiln, impelled by the wind in almost horizontal streams along the ground.

12. 50. P. M. — Two Dust Whirlwinds passed to S. S. W. about 2 miles distant from each other.

The one passed swiftly by the tent, at the rate of 15 or 16 miles an hour, and the circle it formed, was from 6 to 12 feet in diameter. It passed with a rushing noise. A few minute clouds to the S. E. 20° to 30° above the Horizon, the size of a hand, apparently.

1. 30. P. M. — The small scattered patches of cloud passing to South from E. to W. are extending rapidly.

About this time Dust Whirlwinds more numerous, all proceeding in the same direction and following the course of the wind from N. to South. — Many were observed between 2 and 3. 30. P. M.

Five or six were sometimes observed at the same time following one another, and extending to a considerable height in the atmosphere — as may be inferred by the fact, that one was supposed to be distant 700 yards at least; and the distinct columnar appearance was visible to the height of 35° or 40°. Another, 1000 Yards distant, subtended an angle of 60° or more *)

It was again observed, that there were times, when the power by which the dust was whirled into the atmosphere, was much greater than at others — and then a considerable interval would elapse before this was again called into play.

A column faintly visible would be observed all at once to whirl up the dust with great energy, like smoke ascending from a furnace. — This would continue for a minute or two — then cease in a great

*) It must be remarked, however, that as no instrument was used on the occasion, this estimate may be erroneous.

measure, and while the mass of dust was ascending in curling volumes, the column below would be only faintly visible. Then after the same period or somewhat longer, this furions whirling would again commence and continue 2 or 3 minutes — then again cease as before, and remain perhaps a longer interval before it recommenced with like violence. All the time, the two masses of dust, one below the other, separated by an interval of fainter dust, or none at all, would continue to rise higher and higher into the air, and when at a considerable height, the masses of dust would become diffused into a faint cloud, and gradually vanish out of sight.

Two other Dust Whirlwinds were observed, apparently within a short distance of one another, but more than a mile distant, of a slender wavy columnar form, towering into the sky 2 or 3 thousand feet. The whole column would at times undergo an almost instantaneous change of form, becoming more curved or wavy in an opposite direction; and it was curious to observe on such occasions, the simultaneous movement of the whole column — sometimes it would be seen to slope in advance, or it would assume the form of the letter *f*, then become arched and undergo several changes of that kind in the space of a short time. — As these dust columns moved along, the cloud of dust high in the atmosphere, was always in advance, as if the column in contact with the earth was being trailed along.

This cloud of dust, though indistinct as to form, is always seen to be in motion, rolling on like smoke. During all this time the sky was clear, with detached patches of light foggy cloud, forming and again quickly disappearing. This peculiar cloud has been often noticed when the Dust Whirlwinds are frequent. On attentively observing the cloud, which is probably two miles high or more, a rotating motion is observed in its fimbriated edges throughout. —

They are in circular motion, and the cloud dissolves and vanishes rapidly, while this is going on, which was observable in all the clouds that were near enough to be accurately noted. The clouds commenced in the S. E. and accumulated to South, leaving the N. Hemisphere nearly clear. I am inclined to think, that the cloud is influenced by the same force, as acts upon the dust at the surface of the earth — since these particular clouds are commonly noticed when the whirlwind columns are frequent, and during the hottest part of the day.

The dust columns to-day moved at the rate of 6, 7 or 8 miles

an hour, and the wind was only a gentle breeze. They came on at intervals, and ceased for a time — and again, are seen advancing. This enables us to comprehend the cause of the gusts or squalls that take place in a storm, and the intervals of lull.

Towards sun-set, the clouds gradually passed of, as is usual.

The sun-set at 6. 30. P. M., on a cloudless sky, beaming through a golden atmosphere, which was diffused around the setting orb to some distance, occasioned by the atmosphere being impregnated with dust.

State of the atmosphere during the latter end of April and May. Opposite direction of clouds and surface wind.

April 24th, 1851. Sun-rise. Light air from N. E. Sky covered with small detached masses of Cirro-cumuli, like scud cloud, moving from N. to East. Sun in the Horizon lighting up all the clouds down to 15° West.

4. P. M. — Bar. 28.916. Att. Th. 81°. 5. Air 94°. Dew point in house 58°. Sky covered with Cumuli and Cumulo-strati coming up from the South (a brief shower of rain). Wind, gentle; had just before shifted from South to N.

9. 45. P. M. — Gentle breeze E. Cloudless sky. Stars shine dimly.

April 25th. At sun-rise, sky clear, a few light scud clouds (Cirri) seen in Zenith and to N. W. moving from West to East, with a Northerly direction — forming and vanishing, with a rotatory motion throughout. Bar. 28. 812. Att. Th. 80°. Air 77°. Min. Temp. registered 72°.

9. 40. A. M. — Wind rising and falling, with a hollow sound in doors, from S. W. and oscillating 4 points or so. Sky clear; prospect of storm, as the Barometer is low.

10. A. M. — Bar. 28. 820. Att. Ther. 81°. Air 91°; light breeze from S. W. Vane oscillating a little. Sky clear.

1. 10. P. M. — Temperature in sun's rays 120°. Air suddenly Electrical, and passage of Dust Whirlwinds from South to North. Wind oscillating a good deal from South to S. West; general direction S. S. W. Sky obscured with dust to the Horizon.

1. 35. P. M. — A succession of gusts, caused by the passage of Dust Whirlwinds proceeding from South to North. Wind at such times, moderate breeze or higher. Vane oscillates from S. by W. to W. S. W.

general direction being S. S. W. During the passage of these gusts, the Electrical sparks pass from wire to wire — at present about $^1/_{12}$ of an inch long.

1. 38. P. M. — A lull and cessation of Electricity.

1. 39. P. M. Electricity commenced again; goes on Tic-tic-tic for two minutes, then ceased.

1. 45. P. M. Electricity again — then ceased.

1. 50. P. M. Electricity again in tick-sparks $^1/_4$ inch, lasted 4 minutes, then ceased and a lull, during which time, vane oscillated as before. Temp. in the sun 122°.

2. P. M. — Slight Electricity and lulls.

2. 10. P. M. Electricity again and gusty for one minute. During this time, though the sparks from the highest brass wire were vivid, the zinc wire placed some feet below it, and 3 yards or more on one side, gave no indications whatever; — and the brass wire placed below the lofty one, gave but a slight spark at times.

2. 20. P. M. — Electricity again and gusty. Zinc wire slightly affected, — lasted for a minute and a lull.

3. P. M. — Electricity stronger.

3. 15. P. M. — Again stronger Electricity appears.

4. P. M. — Still gusty. Wind S. W. Electricity. Temp. of external air in shade 96°. Dew point 51° 5.

6. P. M. — Before sun-set, this Electrical state of the atmosphere had passed off, and the night was clear.

April 26th. Sky clear, — a light cool breeze from N.

April 27th. After notes. Wind all day from N. N. E. and N. E. and veering in that direction. From about noon, was gusty and Dust Whirls. — Air electrical all afternoon till sun-set and after. Night fine — a gentle cool breeze. Distant lightning to N. E. during the early part of night.

April 28th. Morning clear. Light air from N. Bar. rising.

10. A. M. — Bar. 29. 032. Att. Ther. 79°. 5. Air 85. 5. Dew point 53. 5. Min. Temp. Reg. 67°.

May 5th. Very sultry yesterday. Sun rises pale, behind a low bank of Cumuli. Sky covered with a thin veil of Cirri, obscure and undefined, which marked the beams of the sun in rising. Wind E. soon after, frequent passage of Dust Whirlwinds from E. S. E. to opposite point. Vane pointing to E. by S. and oscillating as the gusts pass. Morning sultry.

9. 15. A. M. — Frequent passage of Dust Whirlwinds from E. S. E. Sky covered with haze and Cirro-cumuli. Great evaporation during the last 36 hours in the sun. Not taken, but there must have been upwards of an inch during that period.

9. 30. A. M. — Masses of light cottony Cumuli moving from S. to N. Wind at times E. S. E.; whole atmosphere, obscured with dust, — air Electrical.

10. A. M. — Bar. 28. 892. Att. Ther. 85°. External air in shade 99°. 5. Dew point not taken. Temperature could not be reduced below 52°, at which point, no ring of dew was apparent. Air Electrical and sultry. Frequent passage of Dust Whirlwinds from E. by S. Day still and sultry. Air still.

6. P. M. — Air obscured with dust. Sky covered with Cumuli, moving slowly from W. to E.

May 6th. Sky so hazy at sun-rise, as completely to obscure the sun.

10. A. M. — Hazy to S. E. Wind veering several points towards the South.

11. 15. A. M. — A light wind from W. by S. and oscillating. Sky hazy.

May 8th. Cloudless sky at sun-rise, — save to the Southern Hemisphere, where are Cumulo-strati up to 30°. The blue of the sky obscured as by a thin veil, which to E. is made evident by the sun's beams showing in light hazy arches in that direction.

10. A. M. — Sky cloudless and clearer. Light wind from W. by N. and oscillating.

3. 30. P. M. — Light wind S. W. unsteady.

6. P. M. — Cumulo-strati moving up from S. by W. to N. N. E. The N. Hemisphere clear of clouds. Soon after, light clouds of dust here and there, which continued to increase and by 7. P. M. were frequent and larger, travelling from N. N. E. to S. S. W. while the clouds were coming up from the South — and to W. S. W. were Nimbi-looking clouds which passed to W. and soon become blended in the sky, forming a haze.

About 7. 15. and 7. 30. P. M. a lull, and no Dust Whirls, but Cumulo-strati still moving up from S., while a light irregular wind blows from N. N. E. Vane oscillating to E. N. E. and N.

7. 40. P. M. — Sky clear, — clouds still moving.

8. P. M. — Sky almost clear to S. a few detached clouds moving

to N. — clouds to N. occupying 6 points; a light unsteady wind from N. N. E.

8. 15. P. M. — Sky nearly clear. A few light cottony scuds passing from S. S. W. to N. N. E. Light wind from N. N. E. and oscillating to E.

8. 25. P. M. — Sky clear.

9. 30. P. M. — A few light clouds moving from S. S. W. to opposite point while surface wind is same.

The night continued clear.

May 9th. Sky clear of clouds at sun-rise.

Sun's disc at sun-rise almost obscured by a fine white haze.

Air still. Vane points to N. N. E.

12. 5. Noon. A Dust Whirlwind of some extent passed from S. S. W. to S. S. E. filling the air with dust.

Wind S. S. W. oscillating to S. and S. by E.

12. 5. P. M. — Passage of Electrical currents from S. S. W., affecting the wire and giving a spark $^1/_{12}$ of an inch. Wind rising and falling at such times, with moaning noise heard within doors, but not without. Vane oscillating at such times 4 points from S. S. W. to S. and S. by E.

2. 15. P. M. — Frequent passage of Extensive Electrical currents from S. to N.

These currents, it may be remarked, now move in exactly an *opposite* direction to what they did last evening at sun-set and shortly after.

4. 30. P. M. — A light breeze from S. S. W. veering to S. W. Sky cloudless all day. Air still Electrical at times.

6. P. M. — A light air from S. W. A few light cottony scud clouds nearly at rest in the Zenith and scattered to the N. W. On attentively observing those over head, the vapour is seen to be in whirling motion, expanding and diminishing.

6. P. M. — and after. Sun setting behind a light hazy bank of cloud. The detached masses of Cumuli spreading over the heavens, particulary to N. Westward. Air still now and at 7 P. M. The clouds in Zenith move slowly from S. to N. Vane points to S. S. W.

10. P. M. — Light clouds to W. Hemisphere moving slowly from S. to N. Air still. Vane points to N. Eastern Hemisphere free from clouds.

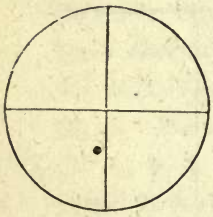
Monthly means of
BAROMETICAL Observations at MEAN MEER for twelve months corrected for Temperature and Capillary action.

	10. A. M.	4. P. M.	
November 1851	29. 439	29. 360	
December „	. 394	. 306	
January 1852	. 325	. 306	
February „	. 324	. 212	
March „	. 208	. 101	
April „	. 103	. 083	
May „	. 002	28. 912	
June „	28. 734	. 703	
July „	. 804	. 732	
August „	. 933	. 842	
September „	29. 028	. 933	
October „	. 217	29. 135	
Sums	109. 511	108. 525	
Yearly means	29. 125	29. 043	

A SPOT ON THE SUN'S DISC SUPPOSED TO BE THE NEW INFERIOR PLANET.

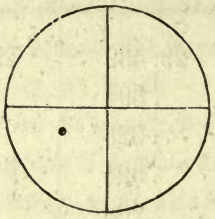
Mean Meer. June 14th., 1853, shortly after sun-rise, a round, dark, well defined spot appeared, visible to the naked eye on the lower limb of the Sun's disc, about midway between the South pole, and the Sun's transverse diameter. Fig. 1.

Fig. 1.



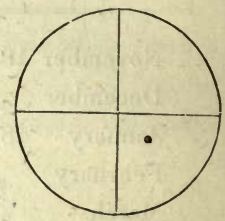
S. Rise

Fig. 2.



S. Set

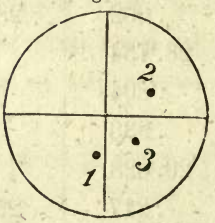
Fig. 3.



S. Rise

Mean Meer. June 14th, 1853.

Fig. 4.



June 15th.

Near sun-set, the spot was still visible, on the lower limb, nearer the Sun's transverse diameter, more to the left, as at Fig. 2.

The following morning, soon after sun-rise, the spot was again visible on the lower limb of the Sun's disc, to the right of the mesial line, and a little below the Equator, as at Fig. 3.

Fig. 4, represents the position of the spots during the 24 hours, from sun-rise on the 14th, to the corresponding time on the following day; and the *chord* described by the planet during that period.

A similar spot was seen on the Sun's disc at sun-rise on the 13th of May, 1851, which was situated on the upper limb, nearly on the Polar axis, midway between the N. pole and the Sun's transverse diameter.

In 1839, in the first week of August, as far as memory serves, travelling between Candahar and Girisk on the R. Helmond, I observed a round, sharply defined, *black* spot on the Sun's disc, both at sun-rise and at sun-set, but cannot recollect whether it was seen the following

morning, nor the exact place it occupied on the Sun's disc, viz. whether at sun-rise it was on the upper or the under limb. This only I do seem to recollect, that at sun-set the position of the spot seemed reversed; from which it would appear that it occupied nearly the same position as in the morning.

The spot was *much larger* and *darker* than that seen on the 13th of May 1851, and on the 14th and 15th of June 1853.

A GOLD REGION ON THE RIVER INDUS.

At Attock, the river Indus, joined by the large Caubul river, commences its course through a rocky defile, which extends upwards of 90 miles to Kalabag, with scarcely a tree and only a few scattered villages to vary the scene, where the mountains terminate abruptly, and the river debouches into the open plain of the Dooab.

The first 65 or 70 miles of this passage is rendered dangerous to navigation, by the tortuous windings of the river through dark rocks jutting into the stream, or rising from the midst of it, past which, the waters rush with great impetuosity, requiring the greatest efforts of ten rowers to keep the boat in perfect command, and prevent its being dashed against the rocks.

In December 1854, when I took this route homewards, the river was low, and a well manned boat stemmed the rapids without much danger; — just sufficient, however, to make one *feel* thankful to a kind Providence for guiding us through safely; — but during the rainy season, or at the freshets, a vast body of water, pent up in this narrow channel, rushes furiously down the gorge, putting a stop to all communication with the opposite shores, except at great risk. The rocks about Attock, (as far as a mere passing glance permits me to speak) appear to be, Slate, Clay slate, Trap, Lime-stone, some of which are continued down the stream for some miles, and are succeeded by stratified rocks, highly inclined and sometimes much cortorted, and lower down, a variegated magnesian Lime-stone, Brick red and grey, in a state of partial disintegration, and Sand-stone conglomerate, at first very coarse, becoming gradually finer, and terminating near Kalabag in lofty precipitious cliffs of fine grained Sand-stone.

At Kalabag the variegated clay hills of the salt range appear, which contain Gypsum, Quartz crystals, and rose coloured rock salt in veins—worked by Government; and in its immediate neighbourhood is

found aluminous Shale, used at the small alum works at that village, to make alum, as well as a non-descript, highly mineralized friable coal, the composition of which is (at least the specimen I procured from the boatmen, which they sometimes munched, and valued on account of its alleged medicinal virtues) as follows:

Volatile matter, inflammable	42. 66 p. c.
Carbon, or Coke	56. 49
Peroxide of Iron, to be estimated as Sulphuret.	0. 85
	100. 00

This differs from another specimen obtained in the same range, more to Eastward, in Sand-stone, which contained 24 p. c. of inflammable matter, an equal amount of Carbon, or Coke, and the remainder, a fine white sand and ash.

Above Attock, at the conflux of the two rivers, looking Northward, the country opens out flat, right and left to some extent, and the widely spread sandy beds of the streams are, in the immediate neighbourhood of Attock, and probably elsewhere, thickly strewed with boulders, and pebbles of every description of primary and transition rock.

Among those noticed, were Granite, Gneiss, Quarz-rock, Quarz, Mica slate, Clay slate, Hornblende, Green stone, Porphyry, Corundum, Lime-stone, Sand-stone, &c. &c. Similar pebbles are found along the river bank nearly to Kalabag, and also in the Sandstone-conglomerate which, low down the stream, forms a principal part of the rocky cliffs on either side of the gorge from about 15 or 20 miles below Kooshalgur, near to its termination.

Viewing the country from this point Northward, the conviction arises, that large tracts of mountain districts have been, during the course of ages, subjected to the disintegrating influence of water and weather, swept away, leaving nothing but their *débris* to mark their previous existence.

This, I believe, is an extensive Gold Region; as gold is found in sands and shingle, both at Attock, and along the entire distance to Kalabag.

On my way down, several small parties of gold-washers were seen washing the sand and gravel for gold at the water's edge.

They were observed 2 or 3 miles above Kooshialgur — again, a few miles above Mackud, — at Mackud, — again, twice, midway between the latter place and Kalabag, — and opposite Kalabag.

They used a shovel-shaped wooden trough, and a coarse square sieve made of reeds, on which was heaped the sand and gravel, and the washing was effected by pouring over it water, from a boat-shaped ladle of wood with a transverse handle in the middle.

The Gold is found in minute grains associated with a large quantity of magnetic Iron-sand; and the final separation is effected by agitating the previously washed sand in a shallow cone-shaped wooden dish, and then using mercury — the amalgam being made into a pill, and the mercury driven off by heat. Two of these gold pills, each weighing about 25 grains, were purchased of the gold washers, and some of their ready washed sand containing particles of gold.

We may readily conceive that the scanty amount that these poor people obtain by dint of hard labour, is no test of the stores of the precious metal which may lie hidden beyond the reach of their minor operations; and it may not be extravagant to suppose that this part of India, now lying barren and almost desolate, with but few inhabitants, may eventually become occupied by an industrious population attracted to the spot by the unexplored mineral riches of the country, and the salubrious climate of the adjoining hills; and thus may our political relations be strengthened, and the elements formed by which the blessings of civilization and religion may be introduced to countless neighbouring tribes, which have hitherto remained unknowing, and almost unknown to the rest of the world, and there an opportunity be given

— "to blow
The trump of freedom", and —
"To tell the bruted slave his manhood high,
His birthright liberty, and in his hand
To put the writ of manumission, signed
By God's own signature; to drive away
From earth the dark, infernal legionary
Of superstition, ignorance, and hell;
High on the pagan hills, where Satan sat,
Encamped, and o'er the subject kingdoms threw
Perpetual night, to plant Immanuel's cross,
The ensign of the Gospel, blazing round
Immortal truth; and in the wilderness
Of human waste, to sow eternal life;
And from the rock where sin, with horrid yell,
Devoured its victims unredeemed, to raise
The melody of grateful hearts to heaven."

The only means of communication between the opposite banks of the river Indus, at Attock, in 1855, was by ferry, and a bridge of boats, which had to be removed during the floods. Since then a suspension bridge has been erected at Attock.

Some miles lower down, below Kooshialgur, the stream narrows in several places, and the rocks seem to approach within 40 yards.

At such points it might be comparatively easy to throw over an iron tubular bridge, and form a permanent communication from India into Affghanistan. —

ADDENDUM.

A few remarks on Sanitary Measures required for the European Soldier in India are offered to notice; some of the same being equally applicable elsewhere.

1. Much difference of opinion prevails among Indian Officers on the necessity of adopting Sanitary Measures in and about Cantonments and Camps occupied by Soldiers.

Some few have supposed that it was healthy rather than otherwise, or at any rate, innocuous, to breathe putrid odours, and the offensive and unwholesome effluvia of Brick-Kilns and Potteries, which are so frequently allowed to taint the air in the immediate vicinity of Cantonments and Towns; while others are either indifferent, or have no clear idea of the importance of strict attention to such matters.

2. Those best aquainted with the laws of health, are fully satisfied, that the welfare of the community is materially affected by the manner in which these things are attended to, or disregarded: — that disease is constantly augmented by the general neglect of cleanliness and by impure breathing.

3. Refuse matter should be speedily buried and a prohibition issued against Brick-Kilns and Potteries within a mile and a half of Military Cantonments.

4. I have noticed with surprise the difficulty experienced by some who have the management of such concerns, to comprehend the requirements for a large body of Soldiers.

The most inadequate means are oftentimes provided; and most of the buildings in question, though generally situated at a considerable distance from Barracks and Hospitals, are usually unprovided with *covered ways;* so that the men, and the families of Soldiers, are compelled, to pass to and fro exposed to the scorching rays of a tropical sun *without shelter.*

5. The very few covered ways I have seen in the Punjab, were introduced by Colonel, now Major General Treminhere: most others who have had the ordering of these buildings, have not been so fully alive to the necessity of the thing as he was, or, covered ways would, doubtless, have been more generally introduced.

6. The above mentioned buildings that have come under my own observation in the Punjab, were from 50 to 60 paces from the Barrack Hospital without a covered way; and in one instance, the distance was about 250 paces, if I mistake not, from the furthest extremity of the Barrack, and 90 paces from the nearest point of approach.

7. In a temperate climate this would be bad enough; but in India, it must prove most detrimental to health, not to mention the painful inconvenience and annoyance to which such an arrangement continually exposes the Soldier.

It is a mistake to imagine, that the European gets inured to such repeated exposure. The baneful influence may be resisted for a time; but, sooner or later, it tells most injuriously upon the health, and may end fatally.

8. Much benefit would result to the service, if young men, destined for the Engineer department were required, before going out to India, to attend a course of study on Sanitary Reform; and were instructed in *practical building,* so as to render them thoroughly conversant with all its mechanical details, which a mere theoretical knowledge can never give.

9. Hospital and Barrack Ventilation by Fan Blowers, or **Thermantidotes,** as they are called in India, in connection with wetted Cuscus Tatties, is the most efficient means for reducing the temperature within

doors, and securing the health and comfort of the European Soldier in India during the hot season.

For Hospitals especially this method of ventilation is valuable.

10. Though commonly used by Officers to cool and ventilate their Houses and Offices in the hot weather, they are, to this day, almost unknown for Hospitals and Barracks.

11. In 1850, in consequence of a favourable report having been made to Government concerning them, a few were ordered for the use of the Hospitals at Lahore by way of experiment, and their success in the Artillery was perfect, as had been the case the previous year; so much so, that, during the unusually sickly Autumn of 1850, when the Artillery Hospital was crowded to excess by fever patients, the air of the building was pure, and entirely free from disagreeable effluvia, and the sick speedily recovered.

It was satisfactory to mark the reviving influence of the cool blast upon some of the worst cases.

12. The Thermantidotes then supplied, were 5 feet in diameter, made of planking, with four fans inside fixed to an iron axle, which worked on antifriction rollers, and was turned by one man by means of a rope attached to a winch.

The instrument was boxed up in the Veranda by means of a thin brick or canvass partition, and the mouth made to open through an inner door way, which was planked up for the occasion, the outer door way being closed by a grass Cuscus Tattie, sloped against the door plate, and the two sides of the Tattie were closed by means of small butresses jutting out from the wall on either side $2\frac{1}{2}$ or 3 feet.

13. The grass Tattie was kept constantly wet, night and day, by water trickling over it from a metal trough 5 inches broad, the length of the Tattie, supported above upon the buttresses, which was perforated along the bottom by a line of small holes, punched from within outwards, like a nutmeg-grater, along the inside of which was laid a strip of cotton cloth, and the trough was half filled with sand.

Into this trough, a constant stream of water flowed from a cistern and stop-cock supported on one of the buttresses, by which contrivance

the Tattie was kept continually wetted, night and day, without much trouble, and a constant blast of cooled air containing watery vapour was thrown into the building continually.

14. One such instrument properly worked, was found sufficient for 40 or 50 men: but in order to render this plan of ventilation generally applicable, and successful, it would be necessary to use an improved blower of smaller dimensions, made of lacquered sheet-iron, and portable, with a fly wheel; every part of the instrument, when in use, being concealed from view for fear of accidents.

In order to complete the circulation of air from below and the discharge of foul air, a few apertures in the roof are required, or top swing windows.

15. *Delirium Tremulens* from excess in drink, is best treated by frequent *warm water enemas;* warm water sponging; effervescing salines, the Acetate of Potass, Ammonia &c. &c. together with moderate doses of Compound Tinct. of Camphor; and sinapism to the epigastrium; with a diet of highly spiced broth, eggs, and strong coffee. This plan was adopted for several years with the best results, the patients rapidly recovering under the treatment.

16. It is a mistake to continue giving to such a patient spirituous liquor of any kind, under the impression that it would be injurious to withdraw it altogether: or because he urgently demands it. A stimulant of a different kind may be given with advantage, without adding fuel to the flame.

17. Most soldiers in India acquire the habit of dram-drinking; and from spirits being presented to them as part of their daily rations, they soon come to regard it as a necessary of life, and too often lapse into settled habits of intemperance.

18. Nothing is more injurious to the constitution than this daily potion: medical men are unanimous on this point, and have urged the Authorities again and again through their Hospital reports, to abolish this pernicious custom, and the Canteen system altogether, and to substitute in its place wholesome beverages adapted to the Climate, and an improved kind of refreshment room.

But nothing is done. Imaginary fears, and rooted prejudices combine to promote the evil, and scores of men die yearly from this cause alone:

On this subject **Colonel Dawes of the Bengal Artillery** writes April 1860.

19. "My experience is that nearly *all* the crime affecting our European Troops in India, has originated in the use of spirituous liquors.

20. By the discontinuance of the morning dram, which was formerly given to the Soldier before breakfast on an empty stomach, and its issue at noon instead, a great advance was made in the cause of temperance in the Indian Army: and this was still further promoted, by the introduction of malt liquor by Lord Dalhousie's order, intended to supersede the use of spirits.

21. I consider abstinence from spirits, a turning point in the life of many a Soldier. The man becomes quite an altered character when he drops this pernicious stimulant; more cleanly in person, respectful to his superiors, and respectable in character; and from the increased dependence that may generally be placed upon him, he becomes altogether a more valuable man, both in the field, and in quarters.

I have seen many a bad character converted by abstinence from spirits, into a steady, able-bodied, hard working, courageous Soldier.

On the other hand, I have remarked, that the best men have, at times, become next to useless from indulgence in liquor.

22. My conviction is, that the less liquor the European gets, the better; but I am not prepared to say that the allowance of a Quart of Beer or Porter is injurious; though many, I am sure, do better without it.

As you are aware, the soldier can do well without liquor, as has been proved on many occasions.

At Jellalhabad this fact was well illustrated. The 13th Light Infantry beleaguered there, was not supplied with spirits during the siege, which lasted *five months.*

The men were nevertheless remarkably healthy during the whole period, notwithstanding incessant hard work, which was carried on with great alacrity and cheerfulness, the men being always well behaved, and good tempered.

24. After the Garrison was relieved, liquor was again issued, and the difference in the conduct and appearance of the men, was very marked.

At Caubul too, in a fine climate, the Regiment was not nearly so healthy as before, from the same cause, and lost many men during the winter months.

25. A great advantage will be gained, when once spirituous liquor is abolished entirely. The Soldier's life in India will then be both a happier and a longer one.

26. The free introduction of Malt Liquor, would enable the change to be effected without difficulty.

Care should be taken, however, to have good coffee and tea provided regularly in every troop and company; and the first thing in the morning, each man should have some offered to him before going out to duty; and also in the evening, as he may desire it. The men soon learn the value of this, and when properly managed, it is alike beneficial to health and morals.

27. I have been assured by one of the ablest of our surgeons in India, that he attributed the remarkable healthiness of a portion of the Troops, in a large station, at a time of great sickness prevailing among the rest of the Troops, to nothing else but the early morning cup of coffee.

28. A man should be selected from each company to superintend the proper supply of good coffee, and be allowed a small profit for his trouble. I believe the men will, in almost every case, willingly join these coffee clubs.

29. With the abolition of the spirit ration, and the general use of coffee instead, I am fully persuaded the average life of the European Soldier in India would be largely increased."

30. My own experience corresponds entirely with what Colonel Dawes says. The arrangement (28) he recommands, is essential to success: when the tea and coffee is bad, or its preparation is left to cook-boys or Native Servants, the beverage is not drinkable, and the men would reject it with disgust, and again have recourse to spirits, or intoxicating liquors.

31. Before commencing hospital work in the early morning during times of prevailing sickness, I have made it a practice to take hot tea or coffee, by which means the constitution has been invigorated, and rendered capable of resisting atmospheric influences, which otherwise, there is reason to believe, would have produced injurious effects; I have thus repeatedly escaped sickness.

Capt. Scoresby on the Arctic Regions remarks: "Whenever I have had occasion to expose myself to severe cold, I have found that the more I am heated, the longer I can resist the cold without inconvenience. The warmth produced by simple fluids, such as tea or soup, is preferable to that occasioned by spirits. After the liberal use of tea, I have often sustained a cold of ten degrees at the mast-head for several hours without uneasiness. I have frequently gone from the breakfast table, when the temperature was 50° or 60°, to the mast-head, where it was 10°, without any other additional clothing except a cap, yet I never received any injury, and seldom much inconvenience, from the uncommon transition."

The beneficial effects of tea or coffee are permanent; whereas those of spirituous liquors, including *malt liquor,* are very evanescent, and leave a corresponding depression of the vital powers, which renders the body more than usually suspectible of fatigue and cold.

Soldiers have informed me, that they have been enabled to undergo long continued fatigue, by only taking tea or coffee, or even water, if I recollect right; while others, who drank Spirits, or Beer, were soon knocked up, and rendered incapable of much further exertion.

Every sportsman, pedestrian, or prize-fighter, must have remarked the same thing with regard to himself.

32. Such truths have been so repeatedly brought forward by medical men, and the advocates of the temperance cause, that one would think there could be no occasion for reiterating them, did not experience

convince us of the necessity of doing so, and of endeavouring by every means to convince those who differ on this point, of the advantages to be expected by adopting the plan proposed for the European Soldier in India, viz. that of total abstinence from wine or spirit.

33. As connected with dram drinking, the ulcerative Dysentery common to Soldiers in India may be mentioned, which I believe is often produced, and always aggravated by the use of spirituous liquors.

The extensive disorganization of the Colon exhibited in these cases after death, is rarely witnessed except in Tropical Climates, and is awful to contemplate.

The impression produced upon the mind when viewing the terrible effects of the disease is, that the unfortunate individual had laboured under it several days before admission into hospital; and that, under blunted perceptions, occasioned by the continuance of spirituous potations, often drugged, he had allowed the disease to make fatal progress before applying for medical relief.

34. When the ulcerative process has proceeded thus far, little hope can be entertained of recovery.

35. When, however, the complaint is of a milder form, considerable relief has been afforded by simple hot water enemata, as recommended by Dr. Hare of the Bengal Army; and by fomentations to the abdomen, hip bath, and flannel swathe; combined with counter irritation by bags of hot Salt, Tartar-Emetic ointment, *covered by a plantain leaf to make it take quickly;* or by Galvanic plates of Copper and Zinc, applied over the region of the Colon, and moistened with salt and water—and a diet, partly farinaceous, and partly consisting of raw or soft-boiled eggs, chicken or mutton broth, tapioca, sago, or arrow-root, jelly or puddings.

36. The medical treatment must be regulated by symptoms; but mild opiates should probably form a chief ingredient in most of the remedies prescribed.

37. One of the most distressing and mysterious affections to which the Soldier is liable in India, is *Coup de Soleil.*

A man previously in perfect health, is suddenly struck to the earth from exposure to the sun's rays, and brought before us insensible, and breathing out his life in Apoplectic stertor.

38. How to act under the circumstances nobody knows for certain. What has to be done, must be done quickly. Copious bleeding, which is generally resorted to, hastens death. A continued stream of cold water over the head, though highly useful, often fails to produce any beneficial effect. The same may be said of blisters, and such like. Yet these are, I may say, the only remedial measures available, or usually practised by the profession.

39. Without disregarding any one of them, used with judgment, (with an especial proviso, however, against copious bleeding) I would suggest a trial of *Galvanism,* applied by means of Pulvermacher's 120 linked chains excited by vinegar; the positive pole, or gold, or copper extremity being applied to the nape of the neck; while the negative pole, or silver or zinc end, is brought into contact with the pit of the stomach, or to the moistened palm of the hand, and there retained for some time.

Mr. P. is of opinion that this mode of exciting the nervous energy would probably prove highly beneficial in such cases.

40. The expressed juice of the unripe *Mangoe* has been recomended as a preservative against *Coup de Soleil,* and deserves trial; and it might, by way of experiment, be given to a patient already so affected by means of the stomach pump.

Lt. Colonel Wakefield, of the Bengal Army, states, that the Natives of India, consider the expressed juice of the *green mangoe* mixed with salt, in doses of a table spoonful occasionally, a cooling remedy, and a preservative against the bad effects of exposure to the sun. He himself has experienced decided benefit from taking it with this view.

41. During the late Indian Rebellion, the Revd. Gobenath Nandy, a Native Ordained Missionary, compelled to flee from the fury of his

countrymen, relates that his child fell sick on the road from exposure to the heat, and became almost comatose, and ready to die, but was recovered by being made to swallow some decoction, or the expressed juice of the unripe mangoe.

42. I have had no experience of the medicinal properties of the Mangoe: the unripe seed and the pulp seem to contain a large amount of *gallic acid*, and citric or malic acid exists in the pulp and the *peel*, with terebinthinous matter.

43. A still more mysterious form of Apoplexy, is that which occasionally attacks patients in Hospital, undergoing treatment for some trifling affection, quite unconnected, may be, with any nervous affection. I cannot, at present, writing from memory, give any definite account of premonotory symptoms; but my impression is, that the individual, without apparent cause, becomes, rather suddenly, incoherent, stares wildly, and soon lapes into a comatose state, and dies in a few hours.

A sure sign of approaching dissolution in these cases, is a sudden accession of the animal heat in an exalted degree, which might be construed by the inexperienced favourably: but is the vital flame kindling up just previous to its final extinction.

This form of the complaint may be connected with some previous nervous debility; a *post mortem* examination reveals no marked evidence of cerebral congestion, or serous effusion, and one feels quite at a loss how to prescribe for the complaint. Bleeding hastens death. It might be relieved by stimulants, and galvanism, as before mentioned.

44. The means provided in the Bengal Presidency for Soldier's washing and bathing has always been quite inadequate for the requirements of men in such an oppressive climate as that of India; though some improvement in the arrangements took place under the administration of Lord Dalhousie, and Sir Chs. Napier, when spacious barracks on an improved plan were built in many of the Punjab Stations under the superintendence of Colonel, now Major General, Treminhere.

45. Plunge baths have occasionally been built to barracks, but they are not at all adapted for the use of Soldiers.

46. Spacious washing houses adjoining the barracks are best suited to their wants; with cisterns, and stopcocks raised a few feet from the floor, where men may wash and refresh themselves after the exhausting heat of the day; a thing so necessary for health and cleanliness.

47. The steam bath has been found useful in acute and chronic Rheumatism, and as a substitute for the warm bath, which can rarely be given in the army.

48. A small tin kettle, tube, and spirit lamp, is all the apparatus requisite.

The patient being seated in a chair, or lying on his cot, is covered with blankets, and a small frame work of bamboo, and the steam introduced under the clothes for half an hour, or more, when after being well rubbed down and dried, he is furnished with fresh clothes.

49. Once, when marching in Sinde, in the cold season, a fine Native Soldier was brought to me bent double and crippled from a stroke of the wind, as it is called in India, in consequence of exposure to the keen morning air.

On being immediately submitted to the process of steaming, he was at once restored. Had it not been for this timely remedy, he might have, if subjected to the usual treatment, lingered a long time and become completely crippled.

50. About the same time, a large Greyhound affected in the same way, and dragging his lower extremities, was restored to strength, and enabled, if I remember right, to make a long march the following day, by being steamed.

A trench was dug inside the tent, in which the dog was laid, and covered with horse blankets, and the steam allowed to play upon him for an hour; when he was enabled to stand, and had no untoward symptom after.

51. Owing to defective hospital arrangement, the *hot bath* is rarely procurable for Troops in India, and the *steam bath* on such simple principles becomes the more valuable.

52. It may well excite surprise, that large European Hospitals should generally lack the means for procuring an abundant supply of hot water for the use of the sick, and for heating bricks, salt &c. so urgently required at times.

The consequence is, that when Cholera rages, or any disease presents itself requiring instant means for restoring the diminished heat of the human body, this valuable therapeutical agent is absent, or available only in a limited degree, and after considerable delay.

53. No good reason exists why European Hospitals should not be provided with large boilers, and sand bath, set in masonry, over a fire place, in the Veranda of the building, where it would occupy but a small space, and be most convenient for all purposes for which heat was required.

54. My experience enables me to say that *Hot* water sponging of the body, affords the greatest relief in Fevers, and alleviates the hot dry skin, and excruciating pains in the back and limbs, more than any thing I ever tried, and is most agreeable to the sensations; while cold water is often disagreeable, and sometimes aggravates, rather than soothes, the symptoms.

55. Sprains and severe contusions with or without lesion, are best treated *from the first* by scalding-hot water fomentations continued for half an hour, or more, followed instantly by a stream of cold water poured over the parts for a minute: then a bandage, or a damp cloth, as the case may require. To be repeated from time to time, (that is, three or four times at least) in the 24 hours.

The relief afforded is immediate, and the injured parts speedily acquire a healthy tone, without the aid of local bleeding; though that may be sometimes used in conjuntion with advantage, when the deep seated parts are injured.

This is also a good method for procuring relief in strangulated hernia, and for relieving certain forms of congestion of the brain.

56. A Freezing mixture of pounded ice and salt, as recommended by an army Surgeon in a pamphlet published some years ago, is a valuable means for arresting hæmorage; relieving congestion of the brain; removing puffy tumours of the bursœ; some forms of Aneurism, &c. &c.

About a cup-ful of the mixture, in the proportion of 3 of ice to one of salt, is tied up in a piece of *gauze* and applied from one to three minutes till the integuments are frozen and white; when it should be removed, and the part allowed to regain its natural condition, which it speedily does, leaving a slight blush, and sometimes a smarting, generally followed by desquamation of the cuticle. It should not be reapplied over the same spot, till after the part has regained its healthy aspect, but may be applied in the vicinity.

57. A European Soldier had a small tumour on his forehead, which proved to be a circumscribed false Aneurism of the frontal artery which seemed likely to extend and involve the neighbouring parts. The freezing mixture applied to the tumour occasionally, together with moderate compression, soon effected a cure.

58. Diseased Bursœ have been removed by the same means, used sometimes in conjunction with acupuncturation and the injection into the sack, previously emptied of its contents, of a few drops of compound Tincture of Iodine, squirted into the puncture, by means of a finely pointed tube of hard glass made into a little syringe.

No bad effect ever resulted from the introduction of a few drops of the diluted Tincture into the diseased bursœ of the wrist and ankle.

Slight inflammatory action arising therefrom, was always subdued by the application of chloroform or an evaporating lotion and, when need was, by a small blister placed above the affected part.

59. *Punctured wounds* of all descriptions, including snake bite, are best treated by introducing without delay into the wound, — to the very bottom if practicable, — a pencil of caustic, so as freely to destroy the sensibility of the wounded nervous tissue (as recommended many years ago by some one) or by carrying a pointed glass tube charged with one of the mineral Acids, into the bottom of the wound; then

placing a narrow strip of blister above, between the wound and the body, so as to confine the inflammatory action to the locality, and prevent absorption into the system.

60. In this way, the bad effect of *punctured* wounds, threatening lock jaw, which might have involved the life of the individual, have frequently been arrested, and the wound converted, more or less, into a simple local injury, which chloroform and warm or cold water applications, with salines, speedily cured.

61. Many Neuralgic affections, chronic inflammation of the Eye, tooth ache &c. have been removed as if by magic, by the use of small plates of zinc and copper excited by salt and water, or by Pulvermacher's chains.

62. Acute and chronic dysentery have also been benefited by the application of the plates over the colon used as a counter irritant; care being taken not to leave the *zinc plate* over the same spot longer than 24 hours together; otherwise, points of ulceration form, difficult to heal.

63. An excruciating and sudden attack of neuralgia of the eye, was speedily removed by the application of a copper plate over the eye, connected, by means of a strip of metal, with a zinc plate applied to the temple.

64. In a case of chronic inflammation of an Eye, connected with incipient capsular cataract, the acute sensibility of the organ, which had resisted a course of alterative treatment and leeching &c. was removed in a few hours by wearing a platinum plate over the affected eye, connected with a zinc disc applied to the temple and excited with salt and water.

65. The external application of hot salt in a flannel bag or stocking, as a counter irritant, in cases of inflammatory sore throat, and pulmonary affections, acute or chronic, is strongly recommended, especially for children and persons of delicate habit.

66. When the tonsils are much swollen, the solid caustic *(argenti nitras)* passed freely and quickly over the surface, followed by hot water gargles, ammoniacal salines &c. has generally been found adequate to arrest the progress of the complaint without depressing the nervous energy.

67. **Poisoning** is frequently practised by the natives of India against each other, and occasionally against Europeans.

The difficulty of detection encourages the crime.

68. Army surgeons are seldom qualified to undertake the delicate chemical manipulation required in such investigations; and if they were, there is no means provided or procurable at military stations or medical Depots, to enable them to do so.

69. In cases of suspected poisoning it has been customary in Bengal Presidency to have portions of the viscera forwarded all the way to Calcutta from the most remote districts, to the chemical Examiner there, for his opinion.

The delay and inconvenience thus occasioned, greatly defeats the ends of justice.

70. Medical men before going out to India, should qualify for this duty, and avail themselves of every opportunity for bringing miscreants to justice, and putting a check to this form of murder.

71. At the close of Autumn, a sudden fall of the thermometer takes place in the Punjab at night and morning, as is noticed in the meteorological notes; and the body, previously relaxed by the heat of a tropical summer, is rendered highly suspectible to atmospherical influences; and the European Soldier is liable to Fever and Dysentry unless guarded against the vicissitudes of the season, by a timely issue of warm clothing, and avoiding exposure to the night air, and early morning parades.

The clothing requires to be at some of the stations of the Punjab, as for instance, Peshawar, of a warmer description even than that considered necessary in Europe.

72. **Want of employement is the bane of the European Soldier in India.**

The heat of an Indian climate obliges him to remain in Barracks during the greater part of the day, month after month; and this necessary restraint is rendered beyond measure irksome by his having no rational employment provided for him. The habit of indolence thus engendered, is a fruitful source of evil, and must have a tendency to enervate body and mind.

Most of the men have been artizans, labourers, or clerks, and might be employed with advantage in some of their former trades, or be taught some useful occupation.

Scientific men would doubtless be found able and willing to organize such a plan if it met the sanction of Government. The attempts that have hitherto been made to introduce trades into regiments for the employment of the soldier have not met with much success, owing doubtless to the absence of proper organization.

Outdoor occupations, as gardening, to which many Soldiers are partial, can only be followed during the cold season; and there are sometimes insurmountable local obstacles to its adoption.

73. What has hitherto been attempted by Government has (Colonel Dawes remarks) not been cordially responded to by the men; and his experience goes to shew, that when employed as tailors, shoemakers, and such like, they generally squander their earnings in liquor, or accumulate them to purchase their discharge.

74. One thing is certain, that nothing can be done to benefit the soldiers' condition permanently until the **spirit ration is abolished,** and most stringent measures enforced against the sale of liquor to the European Soldier; and the daily allowance of Beer limited to a quart bottle.

75. An extraordinary waste takes place in India, year after year, from the condemned clothing and bedding of military Hospitals being burned by orders of Government in the presence of the Medical officer, who is required to furnish a certificate to the Commissariat, that the clothing and bedding was burned in his presence. Many hundred weight of valuable cotton, rags, and hemp, are in this manner destroyed yearly, which might be converted into paper.

76. While writing the above, I have been favoured with the opinion of Major General N. Wyllie C. B. of the Bombay Army, regarding the abolition of the spirit ration —

"I quite concur," he remarks, "in the opinion expressed by Colonel Dawes of the Bengal Artillery in Paras, 19 to 21, that it is very desirable to abolish the Spirit Ration in the Indian Army, because it appears to me to foster a *habit* of dram drinking leading to much evil.

Some years ago when serving in Scinde and Affghanistan, I remarked that little or no crime was committed by our European Soldiers while quartered in those countries, chiefly owing to their inability to procure spirits with the same facility as in India. —

On our return to India many of the Non-Commissioned Officers of one of the same well conducted Regiments, were reduced to the Ranks in consequence of indulgence in spirituous liquors at a Station, where as usual, it was easily procurable.

As to its connection with disease, I have been informed on the best authority, that the intestines of men who have been addicted to drink, are generally found, on *post mortem* examination, extensively ulcerated.

My own observation and experience incline me to assert, that indulgence in spirituous liquor in a climate like India, shortens life to an alarming extent.

A certain quantity of Beer or Porter, without spirits, seems to me quite sufficient stimulant for a healthy man — good coffee and tea, properly prepared, should also be freely supplied morning and evening.

Want of employment is doubtless a source of great evil in the Army.

In addition to the usual privilege of being permitted to work at their respective Trades when off duty, on the Western Side of India, the men have ground allotted to them at the different European Stations for the purposes of gardening; which plan, as far as it goes, has been found to answer remarkably well."

N. W.

Bonn, 30 May 1860.

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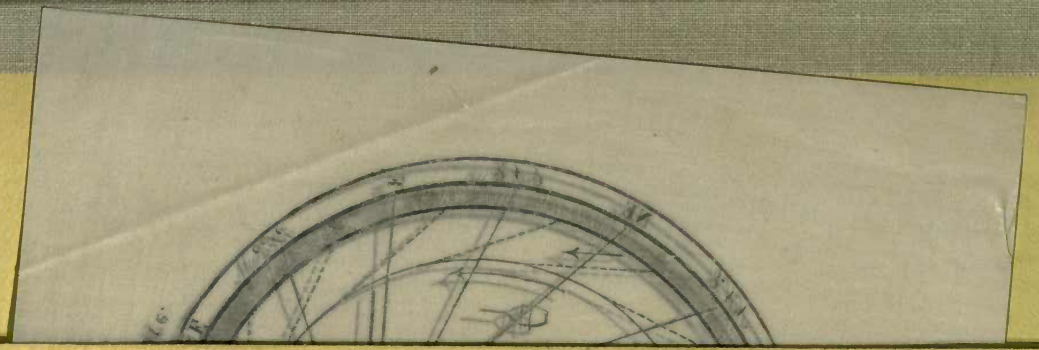

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